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# INDUSTRIAL TECHNOLOGY IN THE 1980s AND 1990s:

# THE CONTRIBUTION OF UNIDO TO

# THE VIENNA PROGRAMME OF ACTION ON SCIENCE AND TECHNOLOGY

# FOR DEVELOPMENT*

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* The views expressed in this document are those of the author and do not necessarily reflect the views of the Secretariat of UNIDO. This document has not been edited.

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TABLE OF CONTENTS


FOREWORD..... iii

INTRODUCTION..... 1

The Role of UNIDO..... 1
Technology and Industry..... 1

I. SCIENCE AND TECHNOLOGY POLICIES AND PLANS..... 4

Industrial Technology Policies and Plans..... 4
Integration of Industrial Policy..... 5
Responses to Technological Advances..... 5

II. CREATION AND STRENGTHENING OF TECHNOLOGICAL CAPABILITIES 8

Standardisation, Quality Control and Metrology..... 9
Engineering Design and Consultancy Services..... 10
Industrial Research and Development..... 12
Information and Documentation Services..... 13

III. CHOICE AND ACQUISITION OF INDUSTRIAL TECHNOLOGY..... 13

Technology Transfer Registries..... 15
Technological Information Exchange System (TIES)..... 15
Technology Advisory Services (TAS)..... 16
Technology Co-operation at the Enterprise Level..... 17

IV. HUMAN RESOURCES DEVELOPMENT/TRAINING INDUSTRIAL MANPOWER 18

Group Training Programmes..... 19
Individual Fellowships..... 20
Study Tours..... 20
On-the-Job Training..... 21
Assistance in Institution Building..... 21
In-house Research Activities..... 22

V. FINANCING INDUSTRIAL TECHNOLOGY..... 22

Investment Promotion Service..... 22
Feasibility Analysis..... 23

VI. SCIENTIFIC AND INDUSTRIAL TECHNOLOGY INFORMATION..... 23

The Industrial and Technological Information Bank (INTIB)..... 24
The Industrial Inquiry Service (IIS)..... 24
The INTIB Network..... 25
INTIB Advisory Services, Training and Technical Assistance..... 26
Information Services and Databases..... 26
UNIDO Technology Publications..... 27

VII. STRENGHTENING R and D and LINKAGES WITH THE PRODUCTIVE SYSTEM..... 29
Industrial Development Centres..... 29
Direct Assistance to Industry..... 31
Provision and Operation of Pilot Plants..... 31
Development and Application of Conventional Technologies 33

VIII. INTERNATIONAL CO-OPERATION IN SCIENCE AND TECHNOLOGY.... 36

The International Centre for Genetic Engineering and Biotechnology..... 36
The International Centre for Science and High Technology 37
Other Efforts in New Technologies..... 38
The Industrial Development Decade for Africa (IDDA)..... 38
Promotional Activities of the UNIDO System of Consultations..... 39
Co-operation among Developing Countries..... 40

IX. INTER-AGENCY CO-OPERATION..... 42

Inter-Secretariat Co-ordination..... 42
Co-ordination at the National Level..... 43
In-house Co-ordination..... 43

X. NEW CONCEPTS AND APPROACHES IN UNIDO..... 43

The Medium-Term Plan..... 44
UNIDO Integrated Technology Programmes..... 45

POSTSCRIPT..... 49

ANNEX: TECHNOLOGIES ADAPTED AND PROMOTED BY UNIDO..... 51

REFERENCES..... 53

FOREWORD

This report reviews the approaches and activities of UNIDO in the application of science and technology in industrial development over the ten years, since the Vienna Conference on Science and Technology for Development (UNCSTD) was held in 1979. After an introduction highlighting the central place technology occupies in the activities of UNIDO, the main types of UNIDO activities are briefly outlined.

The following chapters correspond as much as possible to the eight areas identified by the Intergovernmental Committee on Science and Technology for Development for the implementation of the Vienna Programme of Action (VPA). Finally, "new concepts" that have evolved after UNIDO became a fully-fledged member of the UN family of organisations, as well as the "Technology Programmes" formulated recently to consolidate UNIDO activities in technology development, promotion and application are described.

It is of course very difficult, if not well-nigh impossible, to give full credit to everything that has been done over the post-UNCSTD decade. Consequently, emphasis has been placed on delineation of the approaches, orientations and major thrusts with brief mention of some of the more notable achievements in the application of science and technology to industrial development. Needless to say this does not cover the whole range of policies, programmes and projects in other fields of interest to UNIDO, as articulated in its constitution and mandate.

# INTRODUCTION

## The Role of UNIDO

Within the family of UN organisations, UNIDO is the centrepiece of the industrialisation effort in developing countries. Its role is to promote, encourage, and assist in the development, selection, adaptation, transfer and use of industrial technology a the manner conducive to enhancing national and regional development efforts. UNIDO can be viewed as the catalyst that promotes useful interactions between the industrial actors within a developing country, and between them and their counterparts in other developed or developing countries. Such actors include financial, industrial and government bodies all over the world. To achieve its mandate, UNIDO carries out industrial studies, conducts research in the variety of industrial sectors and country situations, encourages the development and transfer of technology, provides technical assistance to developing countries, operates a unique industrial and technological information system and compiles industrial statistics.

## Technology and Industry

Technology, in the broadest sense that encompasses both its forms (as knowledge and know-how, or as embodied in equipment and products), is a key factor in all human activities and walks of life. However, it is true to say that the majority of our technological wealth is either in industry, or closely related to at least one industrial activity. In fact, technology and industry are inextricably intertwined as in no other branch of economic or social activity. Consequently, technology and technology-related issues figure prominently in most of UNIDO's work. Yet, a clear distinction must be made between building the capability for industrial production and that of building a technological capability in developing countries. One-time transfers of certain technologies may help in building and operating new industrial plants, or rehabilitating older ones. But it takes more than that to industrialise a country. Sustained industrial development calls for the nurture of technological capabilities and a basic technological infrastructure. Thus, in addition to providing technical assistance in industrialisation activities to developing countries upon request, UNIDO is becoming more and more involved in helping them to build-up the sinews of industrial and technological capability. UNIDO's efforts in this area, which date back to pre-UNCSTD years, have culminated in the adoption of the programme approach setting out goals and organising activities to address the wide-ranging issues involved more effectively. The task of developing and implementing promotional programmes that accelerate the industrialisation of developing countries, and the expansion of international co-operation for this purpose, is entrusted to the two technology divisions, viz."Industrial Technology Promotion Division" and "Industrial Technology Development Division", which work closely with the "System of Consultations Division" and the "Industrial Investment Division". The activities of these four divisions, which form the "Department for Industrial Promotion, Consultations and Technology" are reflected and coordinated in particular with those of the "Department of Industrial Operations", responsible for the implementation of technical co-operation projects. While project-by-project activity is necessary for technological development in the industrial field, it needs to be underpinned and directed by all countries coming to grips with technology

at the macro-level and trans-sectoral aspects. This will stimulate developing countries to take actions on their own and to formulate more effectively their requirements for technical assistance. Thus UNIDO complements its project-by-project technical cooperation activities by an overall promotional activity through the establishment of a promotional technology programme.

Technology figures in different ways in UNIDO activities. In almost every one of its activities technology is there, being an integral part of its mandate. UNIDO fulfills its role in this respect through five main types of activity:-

Technical Co-operation

While many developing countries need technology and skills to industrialise, the industrialised world has resources that could assist the developing countries in the industrialisation process. UNIDO seeks to identify the needs and match them with resources in international co-operative efforts, by providing expert advice, consulting services, equipment and fellowships to developing countries. Funding comes from UNDP, voluntary contributions of member states to the Industrial Development Fund of UNIDO, and trust funds established for specific purposes. The global operations of UNIDO cover virtually every branch of industrial enterprise. The Department of Industrial Operations undertakes technical co-operation activities through its three divisions viz.: Industrial Operations Technology Division, Industrial Operations Support Division and Industrial Institutions and Services Division.

Technology Promotion

The importance of promotional activities is reflected in the establishment of two divisions that consolidate UNIDO's various technology promotional activities, whether these be in technological information; choice, negotiation and acquisition of technology, or facilitating technology flows in various ways ;or undertaking awareness programmes or long-term capability building in new technologies.

UNIDO promotes industrial investment through Investment Projects Identification and Investment Promotion Services. In fostering investment in industry in developing countries, they are also concerned with identifying appropriate technologies; since search for resources usually involves, amongst other things, transfer of technology.

Information

UNIDO provides a wealth of information on industrialisation and the economic and social conditions in developing countries, relevant to industrialisation. This includes industrial statistics, studies of particular industries or countries, sources of technological and patent information, from within UNIDO as well as databases of such information worldwide. At present, technology related information is held in eight UNIDO databases. Publications of UNIDO information services include two newsletters, three advanced technology monitors, directories, abstracts and a series of guidelines for entrepreneurs, policy and decision makers.

Apart from maintaining an extensive in-house collection of references, UNIDO is actively involved in establishing national and regional information centres and linking them in a network.

Consultations

The consultations organised regularly by UNIDO provide a forum for representatives of governments, industry and labour unions to exchange information on the prospects of a particular industrial sector or activity. More specifically, the meetings discuss measures of dealing with industrialisation problems, whether these be policy measures or economic, financial, social or technical considerations. The consultations provide an opportunity for those interested in a particular industry to discuss these problems and to evaluate the long term requirements and outlook. This may include the distribution of new plant capacity, the prospects and problems involved in establishing a new production unit in developing countries. The consultations seek to arrive at recommendations and conclusions as regards such issues. Issues relating to technology transfer invariably figure in the deliberations in the Consultation meetings.

Training

UNIDO's training activities recognise the vital role of a well-trained, highly skilled and motivated work force. They assist developing countries to identify their needs at various skill levels and draw up appropriate policies. UNIDO organises specialised programmes to satisfy these needs, through group training, fellowships and study tours. Group training for senior technical and management personnel from developing countries, in different sectors and specialisations, helps to bridge the gap between theoretical knowledge and the requirements of industrial application. Fellowships and study tours, on the other hand, are project oriented. UNIDO promotes also the placement of people in suitable industrial training facilities in developed countries, thus promoting closer technical and economic co-operation among these countries.

We now proceed to review in some detail UNIDO's activities in relation to each of the eight programme areas of the Vienna Programme of Action, highlighting a few specific examples to illustrate the results achieved.

## I. SCIENCE AND TECHNOLOGY POLICIES AND PLANS

Most countries -- certainly most developing countries --need policy tools to maximize the benefits of modern technologies and/or reduce their adverse consequences. Because technology, whether transferred in or indigenously developed, is essential for the industrialization process, a coherent and integrated technology policy, is also essential for developing countries to efficiently implement their industrial development policies. Formulation of national technology policies is seen therefore as an essential element in strengthening the technological capabilities of developing countries.

International organizations are mandated to assist them in this endeavor above all by the Vienna Programme of Action stemming from the United Nations Conference on Science and Technology for Development, held in Vienna, August 1979. This recommended inter alia that developing country governments should formulate a national policy for science and technology covering planning, budgeting, management, co-ordination, stimulation, promotion and execution of scientific and technological activities relevant to defined development objectives. Technology policy should also bring about a careful interaction between factors responsible for growth and transformation.

### Industrial Technology Policies and Plans

UNIDO has responded to its mandates in this area with a number of studies and series of national workshops in developing countries designed to stimulate and assist the formulation of technology policies and plans. Because countries are at different levels of development, no single prescription regarding technology policy can be applied: policies must be evolved at the national level. The approach by UNIDO is therefore twofold: with countries already having a basic capacity to carry out policy formulation UNIDO provides specific help with policies and plans for selected sectors; with developing countries at a lower level of development, UNIDO works with them to provide a minimum basic plan of action and a kit of policy tools relevant to technology.

With more advanced countries, UNIDO assists in sectoral policy formulation, sensitizing governments, industry, and R and D institutions to the need for policy formulation including new technology areas, microelectronics and biotechnology in particular.

UNIDO works with governments to review the status of their countries' technology activities and to formulate technology policies and programmes. These policies include orderly responses to technological change and provide strategies to manage technological change. With the new emphasis on promoting small-and medium-scale industry, on the one hand, and the rapid development of the advanced technologies and their incorporation in industrial processes, on the other, the problems of managing technological change have acquired particular prominence of late in UNIDO's Technology Programme. The general level of technological awareness and capability of the population as a whole, as distinct from scientists and engineers, is essential for smooth technological changes without adverse social or economic effects.

Workshops are organized to promote such policy formulation and sensitise both industry and government to the need for such policies. For example, a survey of technology development and transfer activities was undertaken in Tunisia, with specific reference to technology acquisition, technological information, R and D, and standardization and quality control. The aim was to establish guidelines for development of a more coherent technology policy in the country. Workshops and in-depth studies have also been undertaken in conjunction with government officials in Argentina (information technology), Republic of Cameroon, Malaysia and Madagascar (technology transfer), Kenya and Trinidad and Tobago (microelectronics), and Sri Lanka (science and technology). UNIDO is also participating in interagency technology missions in a number of developing countries, starting with a view to contributing to a system-wide approach for helping endogenous technological development.

**Integration with Industrial Policy**

In all cases technology policy and the plans and programmes stemming from it must be seen in the wider context of the socio-economic development goals of individual countries. For UNIDO, technology has to be an integral part of the overall industrial development policies. Similarly, technology policy has to be integrated with more general policies, such as those on science, education, etc., which are usually of a longer term nature. Some developing countries have included technology as a component of their overall development plans while others have issued separate documents in the nature of technology policies and plans. A larger number have formulated policies on specific technological aspects, such as acquisition of technology or developments in specific industrial sectors. Such countries still require a comprehensive policy framework for national action in technology.

Technology policy formulation also requires complementary inputs in addition to an overall socio-economic/industrial policy--for example the technology information system and a technology monitoring capability. Technology policy has to be dynamic, able to take account of changes in the industrial structure as well as rapid advances in technological processes. Without information and monitoring, national policies on technology risk rapid obsolescence.

**Responses to Technological Advances**

One of the components of UNIDO's activities in the area of technological advances has been the formulation of a systematic approach for developing countries in their responses to these advances. These efforts date back to the early 80's when the International Forum on Technological Advances and Development was held to consider UNIDO's approach to the policy issues involved. This was followed in the same year by a Workshop on the Institutional and Structural Responses of Developing Countries to Technological Advances. The approach that followed started from the premise that the changing world technological scene necessitates that the developing countries rectify past deficiencies and come to grips with this new challenge. Some technological advances have considerable potential for development in developing countries, provided sufficient national and international efforts are undertaken.

On the other side, developing countries need to reduce to a minimum the adverse consequences of these advances and maximise their benefits through a selective policy adapted to their requirements, which differ from one country to the other. Furthermore, the technological advances have to be integrated into the existing conventional or traditional technologies. Regardless of its level of development, each developing country needs to acquire a minimum capacity to monitor and assess the implications of the technological advances for its own development, and formulate its response policy according to its conditions within realistic time horizons.

This approach was endorsed by the Fourth General Conference of UNIDO, held in 1984, and UNIDO was asked to assist developing countries in setting up national groups to carry out these monitoring and assessment functions, and in studying ways and means for more efficient linkages and co-operation between national, regional and international centres, including networks, and to identify the gaps that need to be filled in order to establish centres and networks. The Conference also asked UNIDO to promote an international referral system for the identification of high-level scientists and technologists.

To help policy makers in their monitoring efforts, UNIDO launched a series on "review of global technology trends" drawing attention to the changing international technology market structure in fields such as microelectronics, biotechnology, telecommunications and solar photovoltaics. A case study on the changing technological scene in OECD countries was also published, while a similar study for a number of selected developing countries is planned for 1989.

Over the post-UNCSTD decade, UNIDO has produced several reports, notable amongst which there are no less than 70 reports on genetic engineering and biotechnology, 94 on microelectronics, 18 on new and renewable sources of energy, 3 in the "Development and Transfer of Technology" series, 2 more monographs on appropriate industrial technology, and 48 on technology policy with particular emphasis on technological advances. In most cases, the reports have been linked to meetings or action programmes at national, regional or international levels.

The first of the now well-established and widely read "monitor" series was that on microelectronics which started in 1981. This was followed the following year by that on genetic engineering and biotechnology, and a year later, by that on advances in materials. These monitors have been received worldwide with enthusiasm. Subscribers from developing countries consider them as amongst the most valuable sources of up-to-date information on technological innovations, the international market, and the experiences of other developed and developing countries. Even in the developed countries, they are viewed as the best concise compilation and handy references on their subjects. The editor in chief of a reputable publication on one of these areas offered publicity for one of the monitors in his Journal, while a reader in the U.K. suggested starting a section for exchange of information on the technology requirements and problems of companies and for which they are seeking a solution.

More specifically, UNIDO is assisting developing countries, upon their request, in formulating national policies for dealing with the technological advances. For example, missions of high-level experts were fielded in Kuwait and Vietnam to formulate national policies in the area of biotechnology and genetic engineering. In Kuwait a team of distinguished scientists in several fields of application, ranging from medicine to agriculture, to pharmaceuticals and the oil industry, surveyed the local scene and needs and formulated the framework of a national policy for the application of genetic engineering in satisfying national needs in these areas and the actions needed to achieve this. This outline is currently under review by the national authorities in preparation for a second round by UNIDO experts to formulate concrete plans for each sector. In Vietnam, a senior scientist was of the opinion that the country has some very talented scientists who have had good experience abroad and who have participated in some excellent research in different areas of biotechnology. He suggested practical ways and means by which they could contribute more to the economic and social development of their country. In Trinidad and Tobago, a national workshop promoted by UNIDO has led to a series of policy and programme initiatives in the country in the field of informatics.

It is interesting to analyse UNIDO's approach to the technological advances. This stems from the view that developing countries have to take both defensive and positive measures in dealing with them. These measures have to be transsectorial in terms of overall policy measures and should aim at strengthening capabilities in selected fields.

The defensive measures are felt to be necessary to avert the danger of irreversible economic distortions that indiscriminate introduction of these technologies could bring about in developing countries. The positive measures are essential if the challenge of the new technologies is to be turned into new opportunities for revitalising the development process.

The International Forum has specified three levels of action which UNIDO has adopted in its programme in the field of the advanced technologies.These are:-

Minimum Level: of awareness, monitoring, assessment in relation to national needs; selection and negotiation on the basis of autonomous decision-making

Medium Level : that adds to above the ability to adapt or generate technology

High Level : that adds further the capacity for commercialisation, design, manufacture and competition in the world markets.

UNIDO activities indicate that considerable effort has been exerted, on many fronts and in several ways, to sensitise the developing countries to the urgent need to examine seriously the impact of the advanced technologies on their industrial development. No doubt UNIDO has succeeded in drawing attention to these issues. Nonetheless, there will always be a need for the monitoring and sensitisation activity, particularly in those areas where developments continue at a fast pace

and the new technologies have not yet matured and stabilised. Parallel to this, work should continue to identify those needs of developing countries where application of the technological advances can be beneficial and to clarify the manner in which this could happen.

The next logical step is to move on to operationalisation of the concepts that have been articulated during the sensitisation phase. UNIDO technical co-operation and promotional activities in the fields of micro electronics, genetic engineering and biotechnological and new materials have already given rise to interesting projects and ideas such as a project for carbon fibres in Brazil and a centre for silicon technology in Pakistan, the International Centre for Genetic Engineering and Biotechnology in Italy and India, the International Centre for Science and High Technology in Italy and the promotion of silicon foundry and software houses in developing countries. It is reasonable to assume also that some of the more recent activities in the fields of marine technologies and new materials will lead in due course to characterisation of the appropriate mechanisms for introducing these new technologies in the industrial enterprises of developing countries. Recently, attention has also focussed on clarifying the issues involved in introducing flexible manufacturing systems in industry and to disaggregate clearly its various components so that industrialists grasp more clearly what the components of the new system are.

## II. CREATION AND STRENGTHENING OF TECHNOLOGICAL CAPABILITIES

Since its inception, UNIDO has been engaged in technical co-operation and advisory and promotional activities to build-up endogenous scientific and technological competence and self-reliance in developing countries. Article 2(q) of the Constitution calls on the organisation to "Assist in the establishment and operation of institutional infrastructure, for the provision of regulatory, advisory, and developmental services to industry". The over-riding long-term objective is the establishment in every developing country of a self-functional technological system that links technological development to actual industrial production.

Although much progress can be observed in the creation and/or strengthening of the various components of a technological capability in developing countries, UNIDO has endeavored to bridge several gaps that still exist and to help in building interlinkages and interdisciplinarity, transsectoral and transorganisational, between existing components and industry.

The basic technological infrastructure of a country comprises the physical facilities and human skills needed to support industrialisation efforts in four key areas: standardisation, quality control and metrology; engineering and management consultancy services; endogenous R and D capability, and information and documentation services.

Without these basic technological capabilities there is little chance that industry can use most technologies effectively. Furthermore, it is this basic infrastructure that links technological development to industrial production and promotes endogenous capability building. Such basic capabilities may be in enterprises, in government, in

privately-owned agencies or institutions, or in academic institutions, such as universities and technical colleges. They provide a resource that can independently check the quality of raw materials industry needs, or the products it makes. Through them industry has access to the technology it needs to expand, rehabilitate or reorganise its production facilities, or move into new areas altogether. Without them industry faces great difficulties in marketing, both nationally and internationally. It would have to rely on foreign sources for these inputs and would have no means of adapting technology to its own needs or exploiting locally available materials.

**Standardisation, Quality Control and Metrology**

Standardisation, quality control and metrology are basic to most manufacturing processes and an essential pre-requisite for modern industrial production. They are also fundamental for the development of all industrial sectors in a controlled and logical way and vital for the growth of small- and medium-scale enterprises and the development of a network of feeder industries. They are critical for raising productivity, improving quality and marketability of products and services. Development of these services thus leads to greater co-operation between manufacturers and paves the way for sub-regional and regional cooperation.

In line with the generally accepted and UNIDO-promoted integrated approach to quality control, standardisation and metrology, UNIDO endeavors to ensure that in elaborating, formulating and executing technical cooperation projects, these three components are fully integrated, or at least fully co-ordinated with industrial R and D, wherever necessary. When such projects cover only one of these elements, the other two are taken fully into consideration to the maximum possible extent. Bearing in mind that national resources are sometimes limited and some countries cannot satisfy their own needs, UNIDO encourages the development of a regional approach to quality control, standardisation and metrology activities, thus ensuring that existing and future facilities are used efficiently and promoting regional trade in industrial goods.

UNIDO's programme covers the establishment, organisation, operation and development of the institutional, legal, technical, management and administrative framework for standardisation, quality control and assurance, testing, certification and laboratory accreditation. UNIDO is presently (as of February 1989) responsible for 27 operational projects in 19 countries funded to the tune of US$ 18 million of which 14 follow the integrated approach mentioned above. Most projects are large-scale ones lasting for two to five years, or even longer should follow-up phases be called for. Geographically, the projects cover both the more advanced countries as well as the less developed ones. For example, while five projects were executed in Brazil alone others were executed in Ethiopia, Mauritius and Vietnam (where three centres and a national network were established). Some projects cover the establishment and operation of a National Standards Body (NSB). Others strengthen existing ones, or establish quality certification marking schemes which are usually mandatory for the export of industrial goods. This usually involves the establishment of specialised testing laboratories or the

linking of existing ones. Where a variety of institutions and laboratories exist, the objective is to link them in a network or national system. Metrology projects provide national primary, secondary and working-level reference standards, instrument maintenance and calibration. In a few cases assistance was provided to enable developing countries to adhere to and sign the GATT "Agreement on Technical Barriers to Trade", thus improving the country's trade balance.

**Engineering Design and Consultancy Services**

Engineering design and consultancy services are the part of the infrastructure that mobilizes indigenous manpower, skills and experience to work on industrial projects, leading eventually to replacement of expatriates by local experts. Such national consultancies can play a significant role in ensuring better use of local resources and appropriate technologies. Lack of such technological support service as project preparation, feasibility studies, engineering design and consultancy, are often critical factors in hindering the industrialization process. Such services range from macro-level industrial planning and micro-level project identification, to project implementation, start-up operation and production management.

The engineering design and consultancy service sector acts as the co-ordinator and turnstile between investment and production activities and flows of information concerning technological possibilities. The level of its development is an important indicator of technological and managerial capabilities of a developing country. The growth of local engineering design and consultancy services in many developing countries is slow and fails to meet the large demand of the various industrial sectors for obvious reasons.

Analysis of assistance requests by many developing countries indicates that there is still a large gap in their technology service capabilities in areas such as project preparation, feasibility studies and engineering consultancy. Attainment of self-reliant and self-sustaining industrialization requires the development of an effective indigenous industrial support service. Often the existing engineering design and consultancy service structure does not correspond to the needs of the manufacturing sectors, especially in the area of pre-feasibility studies and design requirements. Two thirds of all established engineering design and consultancy firms in developing countries are concerned with civil engineering and architectural design. Half of those firms are critically involved with feasibility studies related to the financial assessment. In contrast, their experience in designing engineering components and simple equipment is limited.

Many developing countries are still at an initial stage characterized by insufficient training possibilities, heavy dependence on foreign support, relatively small business scale, and as a consequence, limited confidence in them by their potential clients. As a result, national investors go abroad for dependence on foreign know-how, organization of production and outside products.

UNIDO assists by helping build up such consultancies progressively. Initially they offer only preliminary studies and feasibility studies,

moving on as experience builds up to engineering design, tender issuing and appraisal, contract supervision and administration, finally taking care of project management in general. UNIDO also plays a useful role in providing advisory service and technical assistance to enable governments to upgrade national consultancies, for example, by stimulating inter-firm collaboration, in recruitment and employment policies, and by promoting specialization of these firms according to the real needs of the domestic industrial sectors.

Support for the development of indigenous engineering design and consultancy capabilities focusses on identifying the needs of developing countries in this connection and the advice, methods and organizational structures that allow relevant scientific technical and economic knowledge to be gathered and converted into designs and instructions for the construction of specific products. It involves also production planning and management. An essential component of such activities is the encouragement of local engineering design and consultancy functions through experience gathered at the national and regional level. This creates new forms of multilateral co-operation aimed at broadening the scope and structure of industrial support service according to the sectorial and sub-sectorial needs in each country.

UNIDO technical co-operation projects take one of two forms: setting up and support of institutions providing engineering and management consultancy services, or providing such services upon request to specific industries or enterprises. Within the first, UNIDO has established several engineering and industrial design centres in many developing countries. The rate at which such centres develop and provide worthwhile inputs to local industry has been generally slow, since it was related, by definition, to the level of development of local industry and the growth of demand for the services of these newly-established centres. However, in the domain of supporting and upgrading small-scale industry, their impact was considerable. Demand on UNIDO support in this context has maintained a high level over the years and has had beneficial effects in upgrading the products and increasing the productivity of small-scale industrial enterprises. Several original designs of appropriate implements and machinery were produced and have been extensively used. Examples of these projects are too numerous to be cited here. It is worth mentioning, however, that with the new emphasis on the small- and medium-scale industrial enterprise, work is expanding and diversifying. At the more sophisticated level, one recent project in the Republic of Korea aimed at assisting the Korea Design and Packaging Centre (KDPC) to play a major role in the continuous expansion of the export of industrial goods, which represent more than 90% of the country's total exports. Activities include, inter alia, expansion of the design division of the centre, upgrading the standard of industrial design through on-the-job training of designers, and the provision of examples of excellent design of industrial goods. Somewhere between these extremes is the Engineering and Industrial Design and Development Centre in Cairo which has produced several original designs of fairly sophisticated agricultural and transport machinery and participated in the development and testing of a locally-designed general purpose diesel engine. In general, these activities aim at mobilising and utilising local resources, and promoting institutional co-operation.

Experience has shown that institutional projects to help industrial development centres in LDC's do not always yield the expected results. A new approach was adopted in Mali, where assistance was extended to the national centre for industrial promotion to make better use of its human resources by working directly with existing industrial enterprises to solve urgent problems, and by a team approach in the creation of new industries.

**Industrial Research and Development**

Industrialisation is largely dependent upon the efficient functioning of supporting institutions concerned with the creation, operation and expansion of industry. No industrial enterprise can be completely self-sufficient. Even the largest firms in highly developed countries rely on industrial service institutions for technical guidance, advice and information on various industrial activities. The majority of enterprises in developing countries are not in a position to provide all the services they need from their internal resources and are thus heavily dependent on industrial service institutions. Consequently, UNIDO has assisted in the establishment of numerous industrial research and service institutes (IRSIs) in many developing countries in the sixties and seventies. These were meant to provide a basic array of essential services to support the newly-established industries. The IRSIs varied considerably in the degree of achievement of their objectives. Towards the end of the last decade a comprehensive review of their work was carried out jointly by UNDP and UNIDO. This, as well as follow-up actions by UNIDO, culminated in a programme of systematic and continuing co-operation among developing countries, and between developing and developed countries with a view to improving IRSI capabilities. UNIDO promoted co-operation among selected technological institutions, particularly in Latin America, where several specific possibilities for institutional co-operation were identified. UNIDO also participated actively in the formulation of a project to be financed by IFSTD for strengthening the World Association of Industrial Technological Research Organisations (WAITRO).

Notable successes in countries at a relatively early stage of industrialisation can be cited in Guyana, Syria and Tanzania, where technical support has continued for several years and has resulted in tangible achievements. The Institute of Applied Science and Technology in Guyana concentrated on the use of local raw materials in the production of ceramics. Its substantial contribution towards solving overall industrialisation problems of the country is recognised by the government. The Industrial Testing, Research and Development Centre in Syria has established strong working relations with industry and has distinguished itself by expertise in optical technology. The Tanzanian Industrial Research and Development Organisation is now recognised as a key institution fully competent in energy-related matters. Its work in this field is appreciated by the government and the World Bank.

For countries at a more advanced stage of industrialisation UNIDO promotes the establishment of specialised centres and the establishment of linkages with similar centres on a regional basis. It encourages the establishment of closer working relations with local industry and increased funding from clients, rather than from the state.

For example, in a regional network of non-destructive testing institutions in Latin America, initiated in co-operation with the International Atomic Energy Agency and funded by IFSTD, more than ten countries have joined the project. In Mexico, UNIDO has been involved for several years in supporting the National Council of Science and Technology over a wide range of activities, ranging from technology policy, technological programming, project implementation, industrial liaison, to shared-risk financing of R and D in a number of industrial sectors.

UNIDO is now moving more and more into encouraging the exchange of personnel and experiences between R and D institutes working in the fields of advanced technologies, such as optical fibers, robotics and software tools for planning and management. One interesting example is the co-operation between India and Bulgaria in the development of industrial robotics. Each partner has identified the points of strength of the other partner that would appreciably complement its capabilities.

UNIDO is also mobilising international co-operation on R and D in areas of great potential and common interest for developing countries. Two examples are the International Centre for Genetic Engineering and Biotechnology, and the Consultative Group on Solar Energy Research and Application, which will be described at some length later in this report. Similar approaches were adopted in microelectronics, new materials and marine industrial technology. UNIDO has also organized co-operative research with a view to building-up national capabilities. Examples are the co-operative programmes between Trinity College, Dublin, and the Kuwait Institute for Scientific Research, and between the Massachusetts Institute of Technology and Korea University.

**Information and Documentation Services**

Information is the lifeline of industrial development. The types of information needed for this purpose in any country are many: technological, economic, social, business and financial. While a variety of sources of timely and properly-formatted information exist in developed countries and are supported by active demand from industry, the sources of industrial information, whether nationally-generated or from abroad, are rare and not well-developed in developing countries. UNIDO's activities in filling this serious gap have proceeded over the years in two directions. First, by in-house activities that provide a wealth of information to governments and industrial enterprises in a variety of forms, ranging from inquiry services to publications of many types and for many purposes. The second is the establishment and/or support of national and regional industrial information centres and services. These activities are reviewed in detail in the section of "Science and Industrial Technology Information".

## III. CHOICE AND ACQUISITION OF INDUSTRIAL TECHNOLOGY

Industrialisation of developing countries - especially the smaller, less developed ones - depends heavily on the access to imported technology acquired by negotiation through commercial channels. Experience has shown that, in many cases, the technologies acquired fail

to meet expectations due to inappropriate choices, and the inequitable terms of acquisition, at conditions not suited to the local environment and capacity to absorb the imported technology. Unlike commodity transfers, where market prices are fairly well known, the cost and terms of industrial technology transfers must be negotiated. Most developing countries find themselves in a weak position when negotiating with the technology suppliers, particularly if the source is a large international company. Naturally, UNIDO has given special consideration to a range of activities aimed at strengthening the capabilities of developing countries in the negotiation and acquisition of technology, as well as facilitating technology flows from the developed to developing countries. The programme on transfer of technology therefore has two modules: acquisition of technology which focuses on strengthening the capabilities of developing countries in acquiring technology on the right terms, and technological co-operation at the enterprise level, particularly between small- and medium-sized enterprises.

The operation of such a programme involves handling of an integrated and mutually supportive package of elements addressing different levels of decision-making and impacting on different layers of the technology system. The elements on which UNIDO has worked consistently over the years include assistance in setting-up and upgrading infrastructure for the evaluation of technology transfer contracts, the training of negotiators, the systematic collection and analysis of data on technology transfer contracts, studies and publications, and last but not least, advisory services to support developing countries in their efforts to negotiate and acquire technology at fair terms.

UNIDO negotiation workshops and seminars are designed to improve the negotiating skills of government officials and private entrepreneurs of developing countries. UNIDO systematically disseminates studies and reports on assessment of trends in technology transfer, technology sources, reviews of technology flows, and examination of technology transfer and acquisition in specific sectors. Model contracts for technology transfer in specific industries were also published, the ones relating to fertilizers being a notable example, arising through the machinery of consultations.

UNIDO has been working for the last few years on the preparation of a comprehensive manual on technology transfer negotiations. This covers the whole range of subjects that negotiators, decision- makers and government officials dealing with technology acquisition and negotiation should be aware of. Each chapter, of forty or so chapters, starts with a note for the trainer, followed by the subject matter and a set of visual aids. The manual is meant to be a source book for use by trainers in preparing and presenting local case studies, as sets of problems to be tackled by the trainees using well-proven methods.

Other studies are more oriented to the business community for use as working materials. These include legislation on transfer of technology and foreign investment, studies on the jurisprudence and practices of developing countries in evaluating technology transfer agreements and guidelines on specific topics such as joint ventures, sector surveys and emerging licensing practices in new fields such as bio-technology and software. UNIDO also co-operates with industrial associations such as

the Licensing Executives Society and international chambers of commerce in order to bring out the suppliers' point of view. It is interesting to note that UNIDO now benefits from a growing reputation among technology suppliers, who recognise the value of its constructive approaches and educational activities resulting in a better knowledge of the characteristics of the technology market. This has resulted in better understanding between suppliers and recipients and has led to more equitable and mutually advantageous deals.

**Technology Transfer Registries**

Most developing countries have gone through a phase of indiscriminate signing and execution of agreements which were not in the nation's or the enterprises' interests. The main aim of establishing technology registries is to ensure that technology transfer contracts are fair to both the supplier and the recipient and that they promote industrialisation while guaranteeing the judicious utilisation of the country's foreign exchange reserves to maximise local valued added. UNIDO has long been active in supporting government efforts in establishing such registries, formulating procedures, drafting legislation, training personnel and providing expert advice upon request. Geographically, its efforts have ranged far and wide, and have served countries at a variety of stages of industrial development and indigenous technological capability. Special emphasis was placed on the role of the registries as sources of valuable support and help to the technology importer rather than as a controlling and licensing body. Apart from their role in supervising the selection and acquisition of technology, they encourage the improvement of capabilities in identification and selection, develop negotiating skills and positions, and encourage the efficient adaptation of imported technology. Technology registries provide the necessary information for the successful operation of UNIDO's Technological Information Exchange System (TIES).

**Technological Information Exchange System (TIES)**

The UNIDO Technological Information Exchange System (TIES) is a network of technology registries in developing countries, through which they co-operate with one another to make their work more effective. Membership of TIES is voluntary and it provides a basis for exchanging information on the terms and conditions of technology acquisition and for becoming better acquainted with the procedures and rules followed by other developing countries in technology acquisition. Members provide UNIDO with information on their technology acquisition contracts, which is made available to other members upon request. At present 22 countries are members of TIES and information is systematically compiled on almost 10,000 technology acquisition contracts.

Representatives of TIES registries are brought together annually to exchange views on development of the system, their national efforts, and on policy measures for strengthening indigenous capabilities in acquiring, assimilating and developing technologies and upgrading domestic scientific and technological infrastructure. This has strengthened relations between the registries and a more heterogeneous set of bodies, such as those involved in investment and joint venture

promotion, technological laboratories and science and technology policy making bodies.

UNIDO publishes a quarterly "TIES Newsletter" which reports the latest news from the member technology registries, and provides up-to-date information on developments in relevant issues, such as licensing, joint venture agreements and sources of financing. The newsletter publishes the full texts of all legislations, decrees and acts relating to technology transfer and negotiation in developing countries, as well as information on recent publications and meetings of interest.

In order to facilitate access to the information available in the system, UNIDO developed a "computerised registry information system" (CORIS) which embodies the collective efforts and a combined mix of inputs that are very much in line with the spirit and aims of TIES. CORIS is a software tool designed for handling information related to transfer of technology agreements and providing the means for more efficient data collection, storage and retrieval and for interlinking with other computerised information system, national, regional or international. The system is installed in Poland, Nigeria, Malaysia, Thailand Philippines, Indonesia, Algeria and Tunisia and is spreading to other countries and regions, such as Mexico, Brazil, Trinidad and Tobago.

**Technology Advisory Services (TAS)**

Dealing effectively with issues relating to selection of technology, assessment and comparison of offers, criteria in negotiation, the appropriate form for acquisition and the international technology scene in negotiations, requires know-how and years of experience which are not always available in a developing country. UNIDO's "Technology Advisory Services" (TAS) seek to bridge this gap by providing quick and impartial advice to governments and entrepreneurs in negotiating industrial and technological transactions, particularly in major projects. Assistance is offered during negotiation in all matters relating to acquisition, e.g. assessment of alternatives, preparation of tender documents, evaluation of offers, preparation for negotiation, drafting agreements and resolving problems that arise during negotiation.

TAS operates in two ways. First, a desk service at UNIDO headquarters responding to requests for advice on specific contractual matters, e.g. assessing levels of payment, drafting particular clauses, or reviewing draft agreements. Apart from the wealth of in-house experience, useful inputs are also obtained free from outside specialists or institutions, particularly TIES members. The second method is the fielding of missions by staff members, or specialised consultants, to support the national negotiators in complicated negotiations, or in major industrial projects. Assistance has been given to many countries, over the years, in a variety of sectors, the most recent of which were in the setting up of a steel complex, in a joint venture agreement involving machine tools, in resolving a judicial dispute in the construction of a cement plant, and in the selection of technology in a petrochemical company for a phosphoric acid plant.

**Technology Co-operation at the Enterprise Level**

One of the most immediate and successful ways by which developing countries upgrade their technological capabilities is by promoting and arranging plant-level technology partnerships as a means of transferring technology and putting it to use. A number of developing countries already have the mechanisms for doing this in the form of government or other agencies promoting investment and technology transfer. In this respect, concentration on smaller enterprises recognises their advantages and the increasing role they play in the industrialisation experiences of developing countries. An industrial base of small- and medium-scale production units with smooth forward and backward linkages with larger enterprises is highly desirable. Small- and medium-scale enterprises cover a very wide spectrum ranging from the very specialised and sophisticated, to those producing a wide range of technically simpler products and those in rural settings that enhance more equitable income distribution and development between the rural and urban regions. In all cases, it is imperative that these enterprises remain technologically efficient and that they produce good quality goods.

When another enterprise in another country is the source of technology, the technology is more likely to work for the benefit of the recipient country when the scale of the partners matches. This is true even when the technology source is in a developed country. However such sources have, in all probability, never considered developing countries as a market for their technologies. Nor are they, with their limited resources and lack of experience internationally, able to mount effective business campaigns at the international level. It is here that UNIDO steps in to bring the two partners in a mutually beneficial relation.

UNIDO's role has been three-fold. First, it identifies and matches potential partners on the basis of the technological requirements of the recipient and the resources, expertise and capabilities of the source partner. Next, it assists the matched partners in negotiating a mutually beneficial business agreement that facilitates the transfer of the necessary technology. This covers financing travel for negotiation meetings and provision of experts to mediate if requested. Finally, it assists in implementing the agreements concluded between the partners through financing expert services for adaptation, overcoming start-up problems should the need arise, and for training of personnel.

The agreements concluded have not been limited to the sale of products or equipment, or even know-how. They seek a partnership of an ongoing nature encompassing several elements of economic and technical co-operation. They can include marketing arrangements, licensing of know-how, subcontracting/co-production, franchising or joint ventures. They incorporate supportive components for financing, training, management assistance, etc.

UNIDO operates through a designated "national co-ordination agency" responsible for industrial/technological development in both the source and recipient countries and stipulates that potential partners co-operate fully with these agencies. Together with the national co-ordinating agency UNIDO begins the match-up process. Once the potential partners have been identified, agreement proposals are submitted and a negotiation

meeting organised. UNIDO continues to provide assistance until an agreement is finalised and its elements to be supported by UNIDO (training, adaptation, etc) have been identified.

Since its conversion into a specialised agency, UNIDO has given this programme a major thrust and is thus emerging as an efficient instrument for modernization of this important industrial sector. Projects have been taken up between industries in West Germany, France, Belgium and Italy and those in over a dozen developing countries (including India and Thailand in Asia) in metal-working, textiles, agro-industries, leather, foot wear and glass technology. Firms in India and Kenya have worked with counterparts in Sweden; companies in Egypt, Ghana and Nigeria are co-operating with enterprises in Poland; food concerns in China and Thailand are linked with counterparts in Holland; engineering industries in Peru, Cameroon and Tunisia have established working relations with Italy. Work has also extended to the regional and interregional level. One project assists in setting-up co-operation agreements between Italian enterprises and 30 selected enterprises in Peru and Colombia.

Recently, the programme received new impetus extending to enterprise-to-enterprise co-operation in a south-south context. South-south co-operation has the obvious advantage that it results in relatively smoother and deeper absorption of technology in view of the similarities of the conditions prevailing in the source and recipient countries. A recent project involves Indian small- and medium-scale enterprises and those in four developing countries, including two in Asia (Philippines and Malaysia).

One interesting methodology developed to identify precisely the needs of a country and to match them with those of another country is a computerised package on the "Analysis of Technological Complexity" (ACT). It is used in diagnosing the capabilities of existing industries and technologies and identifying complementary capabilities in small- and medium-scale electro-mechanical industries. This seems to be spreading amongst both source and recipient countries, e.g. France and West Germany, and Brazil, Morocco and Algeria.

## IV. HUMAN RESOURCES DEVELOPMENT/TRAINING INDUSTRIAL MANPOWER

People are the fundamental factor in economic growth and productivity. Human ingenuity and entrepreneurial skills are the more significant factors in industry. In the final analysis, financial capital is only an extension of the acceptance of value to facilitate economic interaction, while "machine" capital is only a human artifact that facilitates the use of muscular and intellectual energy. Irrespective of the final blend of resources in an industrial process, it is human economic management - at both the macro and micro levels - that determines the mix and quality of economic inputs and their final outcome.

Human resources development can thus be seen both as a precondition for and a feature of the industrialisation process, as well as a logical outcome. It is of critical importance, since it is the quality, quantity and versatility of a country's human resources which provide its economy with a competitive edge in industrial production and in adjusting to

external shocks. In order to be able to plan, operate and support accelerated industrialisation in a period of rapid change and structural adjustment pressures, developing countries need to ensure that their people acquire higher levels of skills, knowledge, as well as appropriate attitudes.

The goal of UNIDO's human resources activities is to improve the skills and broaden the experience of senior technical, managerial or administrative personnel working in industry or in agencies and institutions involved in industrial development. Participants in these training programmes and projects are usually professionals with a post-graduate education in engineering, economics, industrial management or public administration, who have appreciable experience in industry or industrial research, training and other support services related to industry. UNIDO does not deal with vocational training or with formal education leading to a degree. Activities in these areas are within the competence of ILO and UNESCO respectively.

There are three target groups for UNIDO activities in the field of human resources development. The first, and most prominent group, is the national counterpart staff for UNIDO technical co-operation projects. The second target group is that of the professionals with post-graduate education in technological or administrative sciences holding key positions in industrial enterprises or government departments involved in industrial development. They are thus in a position to apply and disseminate widely the skills and knowledge they acquire through UNIDO programmes. A third group, which is more homogenous, is those training to become trainers or human resources developers. The growing emphasis on the role played by trainers reflects growing recognition of the importance of new educational technologies and training methods. This group has the greatest multiplier effect.

UNIDO is currently assisting developing countries in human resources development for industry mainly through six instruments of technical co-operation:

**Group Training Programmes**

These offer relatively senior technical and management personnel engaged in industry in developing countries the possibility of upgrading and/or updating their skills and knowledge by participating in training programmes designed and implemented in collaboration with governments and pertinent institutions in host countries on a cost-sharing basis. In-plant programmes are carried out by industrial enterprises or institutes with the objective of providing participants with concentrated experience in their fields of specialisation, over a relatively short period of time (2-5 months). These programmes are monitored by experts and usually consist of four components: a theoretical introduction, in-plant training which includes laboratory or similar work, study visits, and a final evaluation session during which the participants assess the value of what they have learned and its relevance to their responsibilities in their home countries.

Other group training programmes in the form of seminars or workshops are of a shorter duration (2-6 weeks). They are intended to provide

participants with an opportunity to exchange experience, and update their professional capabilities in a highly specialised field.

Group training programmes have ranged between 50 and 100/year and have involved between 1,500 and 2,500 participants every year. They have covered a wide variety of subjects and have been carried out in many countries, both developed and developing. Some are now well-established and have become a yearly event, such as the one in modern plastics production and that in synthetic fibre production in Austria, or that on industrial information in the USSR, to name but a few. Group training programmes in developing countries have been as high as 40% of the total.

Group training programmes have recently acquired a new dimension by the increased involvement of developing countries in their planning and implementation. This included the recruitment of trainers from developing countries, enlisting former participants as resource persons, or conducting part of the courses in a developed country and the rest in a developing country. Another approach was to follow up a course in a developing country by exposure to the same type of activity in a developed country.

**Individual Fellowships**

Fellowships are awarded to individuals for study abroad for comparatively short periods of time in fields related to technical or managerial processes. They are generally an integral part of a larger technical co-operation project and are usually awards to national counterpart personnel who will be responsible for operating the project after technical co-operation with UNIDO comes to an end.

One major advantage of individual fellowships is that it allows the design and implementation of a training programme to suit the particular needs and wishes of the candidate and his employer. In spite of difficulties sometimes encountered in finding suitable facilities in highly industrial countries for individual fellows, UNIDO has been quite successful in placing almost all its fellowship candidates.

**Study Tours**

Study tours are organised both for individuals and groups of high-ranking government officials, top managerial staff or national directors of UNIDO-executed projects. The primary aim of study tours is to enable decision-makers to exchange views with their peers in other countries; specialists to obtain information on technological developments; technologists and managers to study solutions to problems; scientists to check the results of their research; and experts to attend conferences to broaden their professional knowledge. Study tours are usually short and range from two weeks to one month, during which period up to a maximum of five countries could be visited.

Organisation of study tours is rather complicated and calls for continuous close co-ordination with numerous authorities, institutions and firms in several countries.

The yearly average of individuals taking part in fellowships and study tours has averaged 2,000. One fifth to one fourth of the 1,000 to 1,500 fellowships and study tours arranged every year has been in developing countries.

**On-the-job Training**

This is provided to project counterpart staff by technical co-operation experts as part of their normal assignment, or by suppliers of major items of equipment with a view to strengthening counterpart capabilities to operate and maintain the equipment.

**Assistance in Institution Building**

Assistance is provided in establishing or strengthening institutions involved in the development of the technical and managerial skills of human resources for industry in the developing countries, whether to industrial training planning units within a competent government authority, the upgrading of an existing unit, centre or institution, or the establishment of a new one.

Experience shows that well-designed and well-adjusted training policies and programmes do not always yield the expected results if due consideration is not given to demand and supply analyses. Some modern and well-equipped centres have been working at part of their capacity, while their graduates have not found suitable jobs because their qualifications did not correspond to the needs of the labour market. UNIDO assists in the development and co-ordination of institutional infrastructures to ensure the optimum utilisation of all existing training facilities in the country, including other industrial institutions, such as standardisation bureaux, research institutions, information centres, and factory-based units, both at the national and regional levels.

Emphasis is placed on improving the infrastructure of the institutions, in particular by training trainers, developing pertinent curricula, introducing appropriate training methodologies and techniques, installing modern training equipment, or enhancing the capabilities of management. Sometimes, assistance is limited to a specific need such as seconding an industrial training adviser to organise industry-university linkages, or organising training programmes at the national level.

Improvement of the training infrastructure of developing countries was boosted by the application of the concept of "centres of excellence". Several such centres have been identified in many developing countries. Their number continues to increase, and they now offer their courses in four different languages. Special emphasis, in enhancing the capabilities of these centres, is placed on the training of trainers, on modular approaches, curriculum design and training methodologies and techniques. The development of these centres is reflected in the increasing percentage of group training courses carried out in these centres, which is now approaching half the total number.

**In-house Research Activities**

In addition to these activities, UNIDO conducts in-house studies and research on various policy aspects of human resources development for industry. Research activities undertaken have included the use of new technologies in the development of appropriate techniques for computer-aided decision support, as well as systems for making optimal use of such techniques in manpower planning for industry.

In addition, ground work was laid for computer-aided training programmes. Moreover, a UNIDO-UNESCO research project was initiated on the development of software for engineering education and training. A new unit working on strategies, planning and methodologies was created to serve governments and other parts of UNIDO in formulating more efficient approaches to industrial development, in which manpower training is an integral part. Research carried out by the unit led to the formulation of a new decision-support system for manpower planning and monitoring, and to the development of new concepts for increased use of simulation techniques on micro-computers for training in different fields. Training courses in R and D fields of special interest were also designed, and the effect and efficiency of training investments analysed.

## V. FINANCING INDUSTRIAL TECHNOLOGY

**Investment Promotion Service**

In general, UNIDO Investment Promotion Service Offices (IPS) act as a catalyst for investment promotion, particularly on behalf of those countries that do not maintain investment or commercial offices in the areas where these offices are located. Some offices offer training facilities in the investment field. The role of catalyst is carried out through investment promotion meetings and by helping developing countries prepare project proposals which could be presented to these meetings. During the meetings, UNIDO arranges a series of discussions between those with projects and those looking for projects.

Between 1980 and 1986, UNIDO's Industrial Investment Programme concluded 432 projects, covering some US$4.0 billion worth of investment in developing countries. During 1985 alone, the programme promoted 99 projects with a total investment of US$628 million, an increase of 100% over the previous year.

Finding appropriate resources to make a project a reality is the main thrust of the programme's services. According to the nature of the project, the required resources may be a joint-venture partnership, direct investment, marketing arrangements or transfer of technology or management expertise.

Over the last decade, emphasis has shifted from organising investment promotion meetings to improvement of the quality of projects and sponsors. Particular attention is given to analysis of the local situation and infrastructure and to the preparation of sound project proposals. In this respect, UNIDO started publishing its series on "How To Start Manufacturing Industries" using technical inputs from developed

countries, e.g. Japan, West Germany and France. These give brief descriptions of manufacturing processes, machinery and equipment, labor, investment and production costs for a wide variety of products. They are designed to stimulate project promoters and sponsors in developing countries and help them identify products for local manufacture.

So far four volumes have been published, each covering tens of products in various fields and for different purposes. Distribution of these volumes is strictly controlled.

**Feasibility Analysis**

Another very successful tool is UNIDO's Computer Model for Feasibility Analysis and Reporting (COMFAR). This is a computerised form of the well-known and widely used "Manual for the Preparation of Industrial Feasibility Studies", which itself has been upgraded and expanded several times and is available now in no less than 16 languages and almost a quarter of a million copies. COMFAR is now available on PC's and has been licensed to more than 200 users in 90 countries. It meets the international project appraisal criteria for the preparation of pre-feasibility studies. A cost-benefit analysis module (ECBA) is also available now in 5 languages, as well as a COMFAR GRAFIX package.

More attention is now given to the development of capital goods industries and south-south projects, e.g. Brazil and India. One other recent development is the tri-lateral co-operation in rehabilitating or upgrading an industry in a developing country. This involves the local enterprise, its customers and a source of expertise in a developed country. A recent example brings together a food processing company in Egypt, together with its clients in the Arab Region, and similar firms in France to help the Egyptian company face competition from Asia in Arab markets.

## VI. SCIENTIFIC AND INDUSTRIAL TECHNOLOGY INFORMATION

The role played by information in industrial development has already been mentioned. Its role in the selection, application and development of specific technologies is becoming more and more crucial in the context of the rapid technological change that has characterised the post-UNCSTD decade. The problem is not only that the decade has witnessed an explosive increase in the types and sources of information, but also the need for the ability to access it using modern information transfer techniques, and to analyse it into an effective decision-support resource.

No organisation, whether in a developed or a developing country, possesses enough knowledge to make decisions entirely on its own. Organizations have to rely on reliable and timely access to information from many sources at a global level. Developing countries in particular lack such capacities and do not generally possess the well-structured information systems and services that can serve both enterprises and government in their industrial development efforts.

Recognising this need UNIDO established in the early days its Industrial Inquiry Service (IIS). Gradually, its industrial and

technological information activities developed, both to build an in-house store of knowledge, and to expand its information services. Finally, all these activities were consolidated under the "Industrial and Technological Information Bank (INTIB).

**The Industrial and Technological Information Bank (INTIB)**

UNIDO's Industrial and Technological Information bank (INTIB) is the developing countries' window on technology. Set up in 1977 after UNIDO's landmark General Conference in Lima, and later endorsed by a UN General Assembly resolution, INTIB generates a flow of specific information needed by developing countries to select the right technology for their own industrial development.

Today INTIB has grown into a comprehensive service offering a combination of on- and off-line information, technical assistance, access to databases and several series of related publications. Its overall task is to compile and disseminate information requested by developing countries and to help strengthen their own industrial and technological information systems. INTIB will search in any field of industrial technology but concentrates on technologies and equipment for 20 selected industrial sectors. INTIB also co-operates with other UN organisations to develop specialized information systems and databases.

**The Industrial Inquiry Service (IIS)**

The INTIB Industrial Inquiry Service (IIS), popularly known as UNIDO's mail order technical assistance, is the developing country industry's link with both the wealth of information maintained by UNIDO as a whole and more than 200 data banks and information sources around the world to which UNIDO has access. INTIB's objective is to ensure a quick, easy flow of selected, analysed and annotated information on manufacturing processes and know-how, equipment and machinery suppliers, criteria and parameters for selecting technology at the pre-feasibility stage, R and D activities, etc. to people who require it when selecting technology. Compared to most other, bibliography-dominated information services, IIS is almost unique in providing concrete, practical packaged information for industrial enterprises in response to specific queries and needs.

At present IIS handles some 1,500 inquiries annually. While most arrive by mail, telex or telephone, an increasing number is now addressed through the growing network of industrial information focal points and nodes in the developing countries themselves. The bulk of the requests is for information on specific manufacturing processes and know-how. One third seek information on suppliers of equipment and machinery.

Nearly half come from industrial enterprises or from national and regional information service agencies requesting information on behalf of industrialists or governments. Other users include engineering and consulting firms, R and D institutions, government policy makers, universities and professional bodies. The bulk of the inquiries relates to three subject areas:

Industrial chemicals, petrochemicals and pharmaceuticals
Agro-industries and food processing
Capital goods and fabricated metal products.

The balance of the requests deals mainly with non-metallic minerals, basic metal industries, textile/leather products, pulp and paper, and wood and wood processing.

**THE INTIB Network**

INTIB has been developing linkages and communications with end-users in developing countries, enhancing their capabilities in the systematic handling of industrial information. It also promotes the availability and utilization of technological information in decision-making processes in industrial development, particularly as technology selection plays an important role in these processes.

End-user linkages enabling exchange and transmission are organized as an INTIB network made up of national focal points (NFPs) and nodes. INTIB deals only with NFPs and nodes, thus ensuring centralised transfer of information from information owners and from those offering information on technologies, to end-users in developing countries. At present, the INTIB network is composed of 150-200 nodes. The location of a national input-output node, its links, types of information to be transferred and network protocols are determined in consultation with the interested countries.

Nodes are information sources specializing in industry and technology. They could be chambers of commerce, associations of small and medium industries, research and development institutions, engineering consulting firms, development banks, technology transfer promotion agencies etc. Plans are in hand to link NFPs and nodes on-line with UNIDO. INTIB has found a successful solution in the IBM screenmail technology which is based on standard and comparatively cheap office equipment of personal computers. The centre of the screenmail system is now functioning at UNIDO headquarters. It connects INTIB with the NFPs and nodes in developing countries and several screenmail communication centres located in the UK, the Netherlands, USA and Japan. This provides communication of user terminals with NFPs, NFPs with one another and with INTIB. At present, 40 national centres are integrated in the network and plans are afoot for adding 30-40 new NFPs every year. One advantage of this system is that it permits further technological improvements, particularly for electronic data interchange.

It is obvious that the state of national communication networks decides whether a country can benefit from these advanced systems. INTIB is offering advice and technical assistance in alleviating this problem.

An interesting experiment is the linking of the Central Scientific and Technical Information Institute (CSTII) in Pyongyang in the Democratic People's Republic of Korea and the Centre of the Scientific and Technical Information (CSTI), and INTIB focal points in Ulan Bator in Mongolia, with UNIDO data bases and the data bases in VINITI and the International Centre of Scientific and Technical Information (MCNTI) in Moscow. This is done via satellite, the Institute for Automated Systems (IAS) in Moscow, and Radio Austria.

**INTIB Advisory Services, Training and Technical Assistance**

INTIB has also been promoting the development of national industrial information policies and centres and supporting the training of industrial information specialists. In addition, it promotes the increased use of industrial information in national activities, and particularly in forging stronger links with the decision-making process. Hundreds of industrial information specialists from developing countries have attended the training courses organised every year in VINITI in Moscow. The INTIB concept is now incorporated in UNIDO technical assistance projects as a means of establishing and strengthening INTIB linkages with information centres and systems in developing countries, ensuring continuous interaction with them, and encouraging and helping them to set-up their own industrial and technological databases, either nationally or regionally.

**Information Services and Databases**

Technology-related information is held by UNIDO in the following systems and databases:

The Industrial Information System (INDIS)- is a computerized form of the Industrial Development Abstracts (IDA), UNIDO-generated information held as some 16,000 titles and abstracts. Some 100 new entries are added each month. These cover technical and other reports, feasibility studies, working papers presented at UNIDO meetings etc. Access is on-line.

The On-Line Information Key (LINK)- houses directories of research and development institutions for specific topics or sectors such as metallurgy, non-ferrous metals, industrial biomass, solar energy. It also provides access to information generated outside UNIDO.

Technological Information Exchange System (TIES)- provides information abstracted from technology transfer agreements of the participating countries. The information is only accessible to members of TIES, i.e. institutions offering similar data on a confidential, reciprocal and mutually beneficial basis.

Energy Information System (EIS)- is an on-line database with an established thesaurus of energy key words. It contains periodical reports on UNIDO's energy activities, manuals and guides on energy technologies and related areas and information packages.

Technology Supply Database- is a compendim of offers of technology, joint venture opportunities and requests for technology. It contains supplier information categorised by industrial sector. An associated "Technology Supply Database Club" is made of members willing to prepare at least 100 profiles of technology offers annually. This is the database for which there is the highest demand.

External Databases- access is provided to bibliographic and directory-type databases. Through INTIB, inquires from developing countries may also gain access to other UNIDO databases, namely:

UNIDO Statistical Database- a central reference point for statistical data in the manufacturing sectors. It contains information on 80 countries.

Investment Promotion Information System (INPRIS)- is made up of five computerized data files:

Profile file - data on over 2,700 industrial investment project proposals in developing countries
investor file - a directory of over 3,000 public and private enterprises
bank file - directory of some 600 development finance institutions
institution file - ministries of industry, investment promotion agencies etc.
sponsor file - developing country firms potentially interested in redeployment possibilities
country investment profiles - general country data.

**UNIDO Technology Publications**

UNIDO publishes newsletters,serials and special reports, directories and abstracts, supporting and emanating from the technology programmes. These include:

The UNIDO Newsletter (monthly, in Chinese, English, French, Russian and Spanish, controlled circulation) - In addition to UNIDO-wide news, it contains information on resources sought by developing countries, resources available to them from industrial enterprises world-wide, and lists of UNIDO publications, reports and forthcoming meetings.

Genetic Engineering and Biotechnology Monitor (quarterly, in English, controlled circulation) - contains articles and news for developing country specialists and policy makers on policy, national developments, research, applications, patents and intellectual property issues and bio-informatics.

Microelectronics Monitor (quarterly, in English, controlled circulation) - covering microelectronics and informatics technology. It contains articles and news for developing country specialists and policy makers on new developments, market trends and company news, legislation and standardization, socio-economic implications, applications, software, national news, developments in robotics and factory automation, and recent publications.

Advances in Materials Technology Monitor (quarterly, in English, controlled circulation) - covers mainly advanced materials (new alloys, composites, ceramics, plastics). It contains articles and news for developing country specialists and policy makers on recent developments, market trends, publications and forthcoming events.

TIES Newsletter (quarterly, in English) - news and developments in technology acquisition, legislation, national registries and the UNIDO Technological Information Exchange System.

Guides to information sources. Covering over 40 subject areas, they list organizations, societies, information sources, directories, statistical

and market data sources, books and monographs, reports and periodicals. Sales publication.

Sectoral directories of technological and related institutions. These emphasize developing country organizations. Listings include areas of interest, staffing, budget, publications and joint projects.

Industrial Development Abstracts. This sales series contains abstracts of latest UNIDO publications and reports, including field reports on implemented technical co-operation projects. They are also available in computerised form on INDIS.

Sectoral Dossiers: Detailed specialist-level information for technology decision-makers in industrial sectors and subsectors, e.g. iron and steel. These are quite hefty volumes laying emphasis on the impact of new technology on developing country operations (available at INTIB nodes only).

Technological Information Packages: Compilations of collected material giving basic information on technological choices in selected areas, with emphasis on experience of developing countries, e.g. mini-steel, cement or fertilizer plants. Describes raw material preparation, production and processing methods, machinery and equipment requirements. They cover technology, economic and financial aspects of particular projects and include lists of process and equipment supplies, and a bibliography.

Guidelines on Technological and Information Policy: Practical considerations for policy makers and senior executives.The series includes guidelines for formulating a national industrial information policy based on country experiences, and advice on setting up industrial and technological information centres, their redesign and selection of minicomputers and software for them.

Technology Profiles: Technological and economic information on selected industrial processes, including descriptions of developing country experiences, quality and environmental control aspects and technology transfer considerations.

Technical Memoranda: Appropriate technology choices in critical and priority areas for small- and medium-scale industries. To date, the series covers tanning, footwear, weaving, vegetable oil extraction, brick-making, maize milling and paper making (jointly published with ILO)

How to start Manufacturing Industries: Brief descriptions of manufacturing processes, machinery and equipment, labour, investment and production costs. They are designed to stimulate project promoters and sponsors in developing countries and help them identify products for local manufacture (Controlled circulation).

Development and Transfer of Technology. Series of over 24 publications dealing with issues such as technology policy, strengthening national capabilities and technology acquisition; offers state-of-the-art surveys in specific industrial technologies.

INTIB co-operation with other United Nations agencies includes participation in the Technological Information Pilot System (jointly with UNDP, UNFSTD and DEVNET), in the INFOTERRA International Referral System for Sources of Environmental Information (with UNEP), in the International Information System for the Agricultural Sciences and Technology (with FAO), the International Nuclear Information System (with IAEA), and in the Energy Conservation Technology Information Exchange System (with UNESCO). INTIB works with WIPO on the patent information system and jointly publishes technical memoranda with ILO, as has been mentioned earlier.

## VII. STRENGTHENING R AND D AND LINKAGES WITH THE PRODUCTIVE SYSTEM

As mentioned earlier, towards the end of the last decade, UNIDO in co-operation with UNDP carried out an evaluation exercise, of the performance of the IRSI's it has helped to establish in many developing countries. The general conclusion was that they have not fulfilled expectations and that they are on the whole marginalised and not very effective in supplying local industry with the inputs it needs. The much needed linkage and free mobility between research, industry and education was mostly missing. One reason was that they did not focus on a particular industrial sector. Given their limited resources and experience they could not impact in a meaningful way on a broad spectrum of industrial sectors, nor could they be effective in the more sophisticated industrial technologies embodied in expensive industrial complexes.

On the demand side, the results of technology transfer can be most unsatisfactory if the recipient is unable to use and adapt the technology to his needs and to those of his markets. A recipient needs to maintain the plant in question, improve its operating efficiency by introducing technical modifications, developing new products, as well as new markets. An understanding of the principles on which the plant is designed and, even better, an ability to carry out design work are most desirable. UNIDO technical co-operation in building up such capabilities include establishing and/or strengthening industrial development centres, direct assistance to industry and the provision and operation of pilot plants. These activities are closely related to those in industrial planning and policy formulation, basic industrial technologies (metrology, standardisation and quality control) and human resources development, already reviewed elsewhere in this report.

### Industrial Development Centres

Many development centres have been established with UNIDO assistance. For example, in the agro-industry sector a leather and leather goods centre was established in the Phillippines, and through the provision of training and consultancy higher quality and better-designed products for the local and export markets were achieved. In China, CAD/CAM techniques in silk dyeing, printing and finishing were applied, thereby improving the competitiveness and added value of Chinese silk products abroad. In Sri Lanka, a textile service and training centre was created, and through the provision of consulting services the quality of textile exports was greatly improved.

In the engineering industry sector, the provision of assistance in setting up engineering design capabilities helps companies to operate their plants effectively and to develop the capability to manufacture equipment locally. It also increases a country's ability to select technology and negotiate technology transfer agreements. For example, UNIDO has assisted in setting up institutes such as the Engineering and Industrial Design and Development Centre in Egypt referred to earlier.

In the chemical industry sector, assistance in establishing petrochemical development centres has been provided, for instance, to petrochemical complexes in Argentina and Turkey, thereby contributing to the efficiency of their operation. Plastics development centres, which have been established in China, Egypt and India, and which are being set up in Pakistan and Viet Nam, can bring about substantial savings simply by improving the efficiency with which the often imported raw plastics are used. Similar economic benefits have resulted from the synthetic-fibre development centres that have been set up in China and India.

Examples in the metallurgical industry sector include assistance provided to a metallurgical R and D centre in India, metallurgical consultancy and training centres in Czechoslovakia and Egypt and to the Instituto Argentino de Siderurgia. The Foundry Development Centre of the Small Industry Development Organization in Turkey helps small-scale foundries to acquire and introduce improved technologies.

Regional centres, often networking with national centres, seem to have served a valuable function in some cases. Examples of these are the regional centre for biotechnology set up in Latin America (Argentina and Mexico) and the regional centres for pesticides and building materials in Asia. The work done in these centres in developing technology can lead to investment projects, if the technology proves to meet requirements. The basic data and parameters for pre-investment studies can be ascertained from these centres.

No doubt, these industry-specific centres are a step ahead from the general-purpose IRSIs of the early seventies. However, unless there is a determined policy and conscious effort to establish strong working relations and interaction with the productive units, they will not fare much better than the IRSIs, if not worse in some cases, due to their sharply-focussed field of interest and capabilities.

UNIDO's recent operations indicate a growing emphasis on the problem of linkages between R and D centres and the productive sector. One recent example is a project in Mexico with the objective of increasing the capacity of the Centre para la Innovation Technologica (CIT) of the National University of Mexico to transfer the technologies developed by the centre to industry. Such transfer usually involve considerable expenditure to bring the development process to full fruition. Judging by the level of funding, there is an obvious need for infusions of "venture" capital to bring the technologies to the market place, as embodied in competitive products.

**Direct Assistance to Industry**

The provision of direct assistance to industry without resort to industrial service institutions and development centres includes advice on the operation and management of industrial plants and assistance in developing new products or those using locally available natural resources.

One of the promising forms of direct assistance has been UNIDO programmes for the adaptation of products for export. The programme of product adaptation assists manufacturers in developing countries to develop, adapt and upgrade their industrial products to the requirements of international markets.

Another area was the conservation of energy, achieved by the re-design of equipment. Additional energy can also be obtained through the application of wind, solar and other forms of renewable energy. UNIDO is carrying out a project in Egypt for the establishment of manufacturing and testing facilities for locally produced wind turbines with a capacity of 15 and 90 kw. Electricity will be generated by the application of new technologies, and the provision of expertise, training and equipment. It is expected that, at the end of the project's implementation, one prototype of each wind machine will be produced and successfully tested for application with stand-alone systems for the supply of electricity on a small scale, water pumping and desalination as well as for wind farms.

Such direct assistance, no doubt, produces useful results. However, this does not always guarantee the enhancement of local capabilities unless it has a strong and carefully planned training component - an approach that would naturally delay the achievement of final results and increase cost, when viewed in a short-sighted manner.

**Provision and Operation of Pilot Plants**

Pilot plants are an important means of transferring and adapting technology. During full-scale operation, the pilot plant can also be used for upgrading, testing additional raw materials and developing new products. Only after successful completion of pilot-plant-scale operations, can a full-fledged feasibility study of an industrial project be started.

Pilot plants are an essential step to full-scale industrial production, and to familiarize the producers with all the related aspects of entering a new field of activity using the proposed technology. Pilot plants have often been provided by UNIDO as part of a development centre, as in the cases of the petrochemical, synthetic-fibre and plastics development centres and have also been provided directly. Examples include a small-scale plant for producing charcoal from cotton waste in the Sudan; and plants for producing salt by solar evaporation in Gambia, Niger and Nigeria to replace the energy-consuming wood fuel process commonly used in Africa. Plants for the production of essential pharmaceuticals in Algeria, Cuba, Tanzania and Vietnam, herbal pharmaceuticals and essential oils in Nepal, Thailand and Turkey are cases where pilot plants have been provided directly. In Burma, in the pulp and paper sector, UNIDO assisted in establishing a pilot plant for

pulp and paper where research for the use of local raw materials, testing and training was carried out leading to the construction of two new paper mills in Burma.

A successful example of pilot plant work in the field of agro-industries has been the development of a detoxification and de-allergenation technology for castor-bean meal which, for the first time, permits the use of castor-bean meal as protein animal feed. The new technology is being demonstrated in connection with a large-scale commercial castor-oil factory in Thailand. The castor-bean meal detoxification and de-allergenation technology is expected to raise considerably the production level of castor-oil plants elsewhere, making it possible to market two products, namely, the oil and the meal. The new technology has resulted further in the elimination of the health risk involved in handling castor-meal to persons sensitive to castor allergen action. Another example is the establishment of a pilot plant for the manufacture of chips in the Democratic People's Republic of Korea. The facility was originally planned for training purposes and was used later for the manufacture of electronic components for local industry.

In the field of chemical industries, a practical example of the transfer of technology is the establishment of pilot and demonstration lime kilns with capacities ranging from 2.5 to 10 tons per day which are fired by either coal, oil or agro-wastes. Similar projects are being developed in Botswana, Gambia, Sao Tome and Principle, Togo and Uganda.

According to a recent report UNIDO has adapted and promoted no less than 56 technologies in the chemical, metallurgical, engineering and agro-industries, of varied scopes and degrees of complexity. A list of these UNIDO-generated technologies is contained in Annex I. Some other notable achievements that merit highlighting here are:

A four-year project with the Cuban government which established a research centre for the industrialisation of bagasse. A good quality, internationally acceptable newsprint from 80% bagasse fibres was developed on a high speed newsprint machine under optimal storage, refining, bleaching and paper-making conditions. The know-how is made available to other sugar cane producing countries to broaden their paper-making fibre resource base.

In co-operation with the Association of Natural Rubber producing countries, assistance was provided in the development of industrial composite materials based on natural rubber in an inter-regional project. One objective was the development of liquid natural rubber and the conversion of natural rubber into forms suitable for use in highly automated manufacturing processes used for conventional synthetic polymers. The project allows simple methods of fabrication and saves labour and energy.

Based on suitable technology and expertise located in India, a multi-purpose plant for the production of essential drugs was opened in Cuba with an estimated output of 242 tons/year. This has upgraded the pharmaceutical industry in the country from dosing using imported active ingredients to a more self-reliant industry. The plant is currently satisfying local demand for several basic medicaments, thus saving as much as 40% of the country's foreign exchange resources.

Perhaps the most ambitious example is in the area of biotechnology started in the Philippines for the production of sucro-based chemicals. This began as a broad-based R and D programme covering some fifteen projects. Eventually it focused on three products of considerable commercial value: citric acid, dextran and acetone/butanol. Work is now moving on to the pilot plant scale.

A plant in India uses non-coking coals to produce sponge iron. This is a technology pioneered by UNIDO, and suits the local conditions of lack of extensive natural gas resources. The plant produces steel by making sponge-iron pellets without using oil, gas or metallurgical grade coke. It uses non-coking coals in a process that bypasses blast furnaces, coke ovens etc., thus reducing capital investment considerably. A demonstration plant had an output of over 100 tons/day. The plant has expanded considerably since then, adding a rotary kiln totally designed in India, thus doubling its capacity. The plant now functions also as an R and D and training centre. UNJDO has used its facilities to test iron ores and coals from Vietnam with encouraging results. The two countries are now co-operating on application of the technology in Vietmam.

An interesting development in UNIDO activities here is its embarkation on such projects in hi-tech fields. Examples are the production of silicon for photovoltaic cells in Pakistan (crystalline silicon) and India (amorphous silicon), carbon fibre applications in Brazil and the Republic of Korea.

In all cases, it is clear that the level of technological competence and involvement of the recipient country has been the deciding factor in the size of the project, the degree of complexity and innovation in the developed technology, and its final impact on the national economy.

**Development and Application of Conventional Technologies**

Established technologies are also changing. They are influenced by the newer technologies on one hand and the trends in their own evolution on the other. Work on conventional technologies is designed to help policy and decision makers in developing countries stay abreast of these developments, especially in areas of immediate development interest.

Energy-related Technology

Energy is a factor of production in nearly all industrial processes. It is also a major industrial sector on its own, supplying both fuel and power for industrial and domestic consumption and equipment for end-users.

In developing countries, energy techologies range from the primitive - animal power, fuelwood - to the most advanced of nuclear power. Fuelwood, is a disappearing commodity and around 1 billion people already suffer the consequences. The direct links between deforestation (resulting in erosion and desertification) and current use by 1.5 billion people of low-efficiency cooking stoves make viable energy strategies and the use of alternative energy technologies not just a convenience but a matter of long-term survival.

The seriousness of developing countries' energy position over the long term led the Fourth General Conference in 1984 to recommend that the developing countries develop integrated energy planning for industry, develop and widen their energy resource base by exploring the indigenous sources of energy in order to increase their self- sufficiency in energy and thus sustain their industrialization process. UNIDO's activities in its energy-related technology programme also reflects related activities in the earlier technology programme. Work on small hydropower, which was started in the late 1970s, focussed on appropriate technologies and local manufacture; a solar energy component stems from earlier work on advanced technologies in microelectronics and new materials, as well as programme elements in the commercialization of research and development.

Prime areas for UNIDO action are three:

Assistance in the development and utilisation of indigenous energy resources, especially renewable resources;
Promotion and support for policies and strategies related to overall development policies and industrialisation plans;
Development of appropriate energy technologies and transfer of energy-saving technologies from industrialised countries.

Modern Technology for the Rural Poor:

Reflecting a growing concern that science and technology are being increasingly directed towards destructive ends, the United Nations General Assembly, in 1983, called upon the international community to take the necessary steps to ensure that "the results of scientific technological progress are used exclusively for the benefit of mankind and for promoting and encouraging universal respect for human rights". In addition, it is clear that the fruits of technological advances have not been evenly distributed. The distribution has favoured the developed countries, and even within developing countries those technological developments that have been brought in, have generally been confined to the urban population.

Consequently, the UNIDO International Forum on Technological Advances and Development, held in 1983, called for "a new form of international co-operation involving a limited number of new and advanced technologies to meet particular needs of a clear and urgent character to the human community".

The UNIDO programme here, stems from the original concept of "technologies for humanity" and has, as its underlying concept, to establish a limited number of specific cases where research, development and dissemination is carried out in the public domain and co-ordinated on a world-wide basis.

Pilot activities have already been initiated covering: upgrading the nutritional value of fermented cassava food, the industrial-scale manufacture and distribution of improved woodstoves, and an international roster of scientists and technologists.

Technologies for Small-scale Industries

The technologies for small-scale industries progamme promotes new industries and modernization of existing ones through development and transfer of technologies that are both suitable in scale and call on only a limited range of resources.

In a typical cycle, UNIDO draws on the results of its system of Consultation meetings, consolidating them with experience in technical assistance to prepare meetings of selected experts. The experts' recommendations are built up into technology and investment profiles for use in promoting transfer of the technology through the normal channels. The work done in UNIDO in regard to food processing and storage, fisheries, and agricultural machinery has led to the international forum on appropriate technology in Africa in those sectors. Another approach has been through co-operation at the "enterprise to enterprise" level, discussed later on in this report.

Appropriate Technologies

A related Appropriate Technologies programme takes a practical approach by working up selected technologies as feasibility studies and investment promotion proposals. In addition, UNIDO systematically promotes appropriate technologies that have been developed in its own technical co-operation projects, e.g. a system for designing wood bridges for rural roads using short lengths of timber and for fabricating them in small wood yards. Such technologies are demonstrated in one or more developing countries, supported by study tours and exchange of experience, and promoted commercially with patents and licences where necessary.

Selection and Management of Hazardous Technologies

The programme on selection and management of hazardous technologies responds to growing concern world-wide that a different approach is needed, especially in developing countries, to industrial safety and impact of some industrial operations on the environment. This calls for the setting up of new organizations and institutions in developing countries, strengthening of existing ones, training - especially at management level - and direct assistance to industry in the fields of pollution control, industrial safety, technology transfer and environmental resources management.

This is a relatively new area of activity for UNIDO. Already several projects have been implemented in handling hazardous wastes and the pollution resulting from them, particularly in the chemical industry. A study has also been carried out on safety measures in biotechnology and genetic engineering. UNIDO is co-operating with UNEP and the International Atomic Energy Agency on the drafting of appropriate safety measures in industry and dealing with industrial accidents. It is also building a database of non-polluting and low waste technologies.

It has to be admitted that in promotional activities work on the conventional technologies has generally drawn on the work done in the technical co-operation activities and Consultations and has not been at

the same level of scope and depth as that on the new technologies, except perhaps for hazardous technologies. The "technologies for humanity" concept has yet to bear the full fruit of the expectations pinned on it.

## VIII. INTERNATIONAL CO-OPERATION IN SCIENCE AND TECHNOLOGY

Several UNIDO activities in the past decade have been designed and implemented as subregional and regional projects involving several countries. Some have also brought together developed and developing countries from different regions. Many examples of this sort of international co-operative level, specific to technological development issues, have been cited and briefly described in the previous pages.

On a truly international scale, we discuss three examples of different objectives, geographical scope in the field of integrating science and technology in industrial development.

### The International Centre for Genetic Engineering and Biotechnology (ICGEB)

This is perhaps the most ambitious international venture launched this decade. UNIDO can take credit for being the leader in undertaking the task of turning the realisation of the potential of recent advances in genetic engineering into a work plan and launching it at a time of aversion to internationalism and towards more bilateralism, and severe financial constraints on all UN organisations. The choice of genetic engineering and biotechnology for the creation of an international centre is itself significant. It reflects an early awareness of the potential of these new technologies, particularly for developing countries, the narrowing of the opportunity window for entry of the developing countries in this field, and the multi- and transdisciplinary nature of any worthwhile effort in its harnessing to their development needs.

It is both interesting and instructive to review how the centre came to be established in a generally unfavourable international climate. First, there was an exchange of views on the implications of the advances in genetic engineering by a group of leading scientists in the field, as early as the beginning of 1981. They recommended the establishment of multi-disciplinary core groups at the national level in developing countries and the setting up of an international centre to provide initial impetus and support to national efforts. The next round of expert interaction took place in 16 developed and developing countries. These formed the basis for a proposal for the establishment of the international centre, detailing recommendations on its functions, work programme and organisation.

After several governments had expressed their interest in establishing and/or hosting the centre, a high level meeting was held in December 1982, in which it was decided that the centre should be established. Less than a year later, a ministerial level plenipotentiary meeting approved the final form of the statutes of the proposed centre. The delicate issue of the location of the centre was perhaps the toughest political hurdle to be overcome. In April 1984, a plenipotentiary meeting decided to locate the centre in two components, namely in Trieste, Italy, and New Delhi. As of the Summer of 1988, 41 countries had signed the statutes of the Centre.

A preparatory committee, composed of the original signatories of the statutes in 1983, took a number of steps in its numerous meetings to turn the idea into a functioning reality. In 1986, a high level scientist was appointed as director and an interim work programme to the tune of US$ 18 million was adopted and is being implemented as a UNIDO project. A five year programme to start in July 1989 is now being drawn up based on the total committed funds of US$49 million. This covers the fields of agriculture and human and animal health, to be essentially dealt with in New Delhi; and industrial microbiology, energy and pilot plant activities, to be carried out in Trieste. Throughout this period a panel of outstanding scientists, including three Nobel Prize winners, has been advising the Preparatory Committee.

Concomitant with these activities, and also as a result of them, significant activities started in many developing countries. Many member countries of the international centre have requested affiliation of their national centres or networks with it. Affiliations have now been granted to Algeria, Argentina, Brazil, Bulgaria, Chile, China, Ghana, Cuba, Egypt, Greece, Nigeria, Venezuela and Yugoslavia. Technical assistance has also been provided to other member countries as mentioned earlier.

All the omens seem to indicate that the Centre will achieve the hopes pinned on it. One observation that must be made, however, is that because of the very nature of the technological advances in genetic engineering the activities and changes will cover a field wider than the industrial sector alone. At the same time the issue of industrialising research results may become less relevant once the Centre leaves the UNIDO "incubator" and stands on its own feet within the international framework of organisations.

**The International Centre for Science and High Technology**

This is an even more ambitious initiative than ICGEB. Bearing in mind the intimate relations that now bind science and technological advances so closely together, and that the standard of living of a nation now depends on science and technology, the idea is to establish an international centre for science and high technology composed of three institutes dealing with materials and high technology, pure and applied chemistry, and earth and environmental sciences.

Detailed draft proposals have been prepared by the UNIDO's New Technologies Unit in close co-operation with and supervision from Nobel Laureate Professor Abdul Salam, the Director of the International Centre for Theoretical Physics (ICTP) in Trieste, and Chairman of the Third World Academy of Science. The Government of Italy supports this project.

This is a logical development of previous initiatives to set up ICTP and ICGEB; but obviously much more ambitious, since the initiative now has to move across a broad front of specialisations and activities. Should such an integrated multi-disciplinary "science park" finally materialise, it will no doubt have a profound impact on the pace and outcome of development efforts in many of the developing countries.

**Other Efforts in New Technologies**

Within the same framework of international co-operation but on a smaller scale, there have been other efforts in some of the new technologies.

In microelectronics and informatics, an expert meeting, also held in 1981, while emphasising the importance of national actions, recommended actions at the international level, particularly a continuous monitoring of trends and analysis of their impact on the various industrial sectors, as well as the development of pilot projects and programmes dealing with applications, software, and certain activities at the regional level. The monitoring is now carried out quite comprehensively by UNIDO's "Microelectronics Monitor," the first of its monitor series. The impact of microelectronics on restructuring world industry was also investigated in two studies of UNIDO's programme of industrial studies.

Although the International Forum on Technological Advances and Development held in 1983 suggested establishing an international centre for microprocessor applications, because of the obvious differences in the national scenes in this field compared to genetic engineering, UNIDO has been working first on a series of national and regional studies to formulate meaningful long-term approaches and objectives for such a centre.

However, a Regional Network for Microelectronics in the ECLAC Region (REMLAC) was promoted. A regional project for Latin America is being funded by the UNDP. Several studies were undertaken to assess the state of the art in microelectronics and government policies for data-processing industries in selected Latin American countries.

Yet another recent example is in the field of marine technology. At the request of the government of Malta, UNIDO, UNEP and the International Ocean Institute carried out a feasibility study for establishing a Mediterranean Centre for Research and Development in Marine Industrial Technology. The study will be discussed in the spring of 1989 and this will hopefully lead to practical steps to establish a viable centre.

**The Industrial Development Decade for Africa (IDDA)**

This is another very different and large scale programme, covering the period 1982-1990. It was designed and implemented as a follow-up to the Lagos Declaration and Plan of Action which itself is derived from the Monrovia Declaration of Commitment of the Heads of States and Governments of the Organisation of African Unity. The IDDA programme, prepared jointly by ECA, OAU and UNIDO, stresses that the industrial development strategy of import substitution to satisfy the demands of a small and relatively affluent group,followed in most African countries in the post-colonial period, is not in harmony with the policy of self-reliance and self-sustainment of the Monrovia Declaration.

Implementation of the programme has involved an investigation of the Africa-related activities of 14 other UN bodies and the way they address the Lagos Plan of Action and the manner in which activities of the Decade can be successfully harmonised with theirs.

What interests us here are those parts relating to industrial technology and its role in achieving the IDDA target of at least 1.4% of world industrial production in Africa. In fact, many of the activities undertaken under IDDA have addressed one or more of the eight areas of the VPA, and have already been touched upon. These were both at the national and regional levels and have covered traditional, conventional and some advanced technologies. Some projects have involved co-operation between African countries or regions and developed ones.

No final judgement can be passed as yet on the degree of success in achieving the quantitative and qualitative targets of the programme. However, it is unlikely that the programme has not been affected by the deteriorating economic situation on the continent as a whole and the constraints on UN resources. All the same, through review of UNIDO annual reports of the Executive Director, it is still possible to see that commendable achievements have resulted, mainly in countries other than the LDC's, particularly in institutional infrastructure, manpower development technology acquisition, and technological innovation.

**Promotional Activities of the UNIDO System of Consultations**

The system of consultations is an international action-oriented forum that brings together some 70-125 participants: individuals or representatives of organisations and governments from both the developed and developing countries to review the global scene in an industrial sector and reach recommendations addressed to the participants and as guidelines for UNIDO technical assistance activities.

The consultation meetings are preceded by the preparation of a global study of the industrial sector, the convening of a global or regional preparatory meeting, as well as a number of expert group meetings in which the precise problems to be considered by the consultation are defined. An advisory panel, often composed of representatives of the respective divisions, advises UNIDO after the meeting on the optimal manner of implementation of the recommendations and the preparation for further consultations.

A number of consultations have been held for 9-12 industrial sectors, with some held several times for the same sector. They review the changing world scene and the progress in implementation of previous recommendations. Examples of the sectors covered are pharmaceutical, chemical, fertiliser, leather, fisheries, small-scale industries, agro-based, wood and wood products, metallurgical industries and industrial manpower training and maintenance of agricultural machinery and capital goods. Technology is a basic element in each consultation and technological aspects occupy about one third of the scope of its work.

The reaction of the participants has been quite enthusiastic. A number of countries which offered host facilities for a consultation meeting have done so again, either to other industrial sectors or for a second one in the same sector. Some have expressed the view that the consultations are an effective part of the North-South dialogue, others that they stimulate thinking about a variety of possible applications of technology, particularly in small- and medium-scale plants in certain sectors.

Future emphasis in organising consultations will be placed on agro-based industry, restructuring and rehabilitation, in an effort to help the developing countries increase their share of the total world industrial production.

**Co-operation among Developing Countries**

Besides co-operation with developed countries, one other main thrust in the industrialisation of developing countries is co-operation amongst the developing countries themselves in joint efforts to promote the rational and efficient use of human, material, financial and technological resources. Such co-operation is an important means of strengthening their economies and their individual and collective self-reliance.

UNIDO was among the pioneer agencies in promoting and implementing projects both in economic and in technical co-operation among developing countries (ECDC/TCDC). Activities towards achieving this goal have concentrated on promotion, technical co-operation and perspective analysis. Consultations and industrial policy have been dealt with at length and those TCDC elements in them were highlighted. Without belittling the importance of ECDC, we concentrate here on TCDC.

Promotional Activities

Most prominent among these have been the solidarity meetings. Several countries expressing interest in becoming involved in industrialisation of a particular country get together and examine a portfolio of projects prepared with the help of UNIDO. The discussions are usually intensive and business-oriented. On the basis of these discussions, each participating country declares its interest in a particular project, or projects. Over the decade, 2-3 solidarity meetings have been held each year. Examples of the countries where such meetings were held are Bangladesh, Haiti, Lesotho, Mauritania, Nepal, Sudan, The United Republic of Tanzania, Upper Volta, as well as The Yemen Arab Republic.

Two essential ingredients for the success of these meetings are careful and thorough preparation of the project portfolio and continued effort and support in the implementation of the agreements reached. By necessity, this involves review of several technological issues, such as the appropriateness of the technology and products, the sources of raw materials and the training requirements.

The solidarity meetings have also been enlarged in scope to cover both inter-regional co-operation (such as the Latin America/Africa meetings on promoting industrial co-operation or the Afro-Asian industrial co-operation meeting), as well as those of a bilateral nature (such as co-operation between Egypt and China in phosphate mining, processing and rare-earth extraction; between Burundi and Romania in the construction of small industrial units, or between Cuba and China in micro and mini hydro-electric plants and the production of newsprint from bagasse).

Another promotional activity has been the holding of workshops or expert group meetings, attended by participants from developing countries, to address specific technological problems in an industrial

sector, such as that held in 1984 on industrial co-operation between developing countries; the ESCAP meeting on implementation of TCDC; the round-table ministerial meeting on food-processing industries, or the one on available technologies for small- and medium-scale industries, and many others that focus more specifically on technological issues.

Promotion at the enterprise-to-enterprise level is discussed elsewhere in this report. It was noted that more emphasis is now being placed on such co-operation between enterprises in developing countries. UNIDO matches the needs of a particular country with the industrial capacities in other developing countries. Recent examples are the completion of inventories of Brazilian capabilities for small- and medium-scale enterprises, and Romanian capacities in the field of chemical and petrochemical industries. It is hoped that these will result in co-operative arrangements mutually advantageous to the parties involved.

Technical Co-operation in Support of CDC

As can be seen throughout this report, many technical co-operation programmes have a strong ECDC/TCDC flavour. About one half of the projects implemented in the area of group training were in developing countries. Many of the institutes, centres and pilot plants established with technical support from UNIDO transfer their wealth of knowledge, experience and technologies developed in them to other developing countries.

System of Consultations

This has been reviewed in the previous section of this report. Suffice it to emphasize here the regional consultations for identifying specific areas and opportunities for co-operation amongst developing countries in a region or subregion, notable among which are those on training of industrial manpower, pharmaceutical industries and the leather products industry.

Industrial Policies and Perspective Analysis

A special division in UNIDO carries out comparative analyses of the experience of developing countries in the formulation and implementation of plans, policies and strategies for industrialisation. This involves review of the role TCDC can play in this respect and the forms it could take. The latest contributions have been a study of new forms of regional industrial co-operation policies presented to the ASEAN summit meeting in 1987; a high-level expert meeting on industrial strategies and policies in Latin America; a study of the small- and medium-scale industry sector in member countries of the Gulf Co-operation Council (GCC), and a meeting on promoting joint ventures among Islamic countries.

While ECDC/TCDC has no doubt been useful in highlighting and promoting individual and collective self-reliance, reviews carried out by UNIDO indicate that practical results have fallen short of expectations or the full exploitation of the potential of technology sources in the more advanced developing countries. Furthermore, the approaches and mechanisms for such co-operation have tended to model themselves on experience in North-South relations. It is worth noting here that UNIDO

prepared guidelines for the establishment of multinational production enterprises in developing countries. This indicates the need for more imaginative approaches and mechanisms that reflect the significantly different motives and balance of relations between co-operating developing countries, particularly in technology transfer where a wealth of useful technologies of worldwide standard are now available in the more advanced developing countries.

## IX. INTER-AGENCY CO-OPERATION

This report would be incomplete without a brief mention of UNIDO's co-ordinating role in the UN system in issues related to industrial development. The preamble of UNIDO's constitution calls upon it to "play the central role in, and be responsible for, reviewing and promoting the co-ordination of all activities of the United Nations system in the field of industrial development". The UNIDO General Conference called on the Director General to "continue to strengthen the co-ordination with other organisations of the United Nations system and with relevant governmental and intergovernmental organisations, as well as with non-governmental organisations whose work was related to that of UNIDO".

The purpose of co-ordination is to increase the effectiveness of industrial or industry related activities so as to avoid duplication or contradiction of efforts to the greatest extent possible. Much more important though is to ensure that co-ordination, while aiming at complementarity and mutual support of activities, does not stifle initiative and innovative responses to problems.

Co-ordination is conducted at different levels: the intergovernmental, the inter-secretariat, the country and the in-house levels. We do not dwell here on the first, since it is essentially the task of the member states, and for which the appropriate mechanisms exist.

### Inter-secretariat Co-ordination

The Administrative Committee on Co-ordination (ACC) is the established structure for policy and UN system-wide co-ordination at the inter-secretariat level. Presently, UNIDO is chairing the Task Force on Science and Technology for Development. At the operational level, inter-agency programme co-ordination covers field activities in technical assistance projects, as well as support programmes of research and studies. While the latter are easier to co-ordinate, co-ordination of field projects is done through joint programming missions involving the representatives of the Governments concerned, the local UNDP resident representatives and representatives of interested UN agencies. Examples of projects that lend themselves more than others to this sort of co-ordination are river basin development schemes, projects in such fields as pharmaceuticals, telecommunications and agro-based industrial-related projects.

UNIDO also has interagency agreements, memoranda of understanding and joint working committees with more than 10 UN organisations. An interesting development, subsequent to the establishment of UNIDO as a specialised agency, is the change of emphasis from the restrictive

approach delineating the areas of competence of each party to the development of joint programmes and the identification of opportunities for co-operation and complementary activities. Furthermore, co-ordination efforts are not confined to the UN system but also involve other intergovernmental organisations at the regional level, e.g. South-East Asia and the Arab Regions. Co-ordination with the relevant regional economic commissions has been maintained since their inception.

**Co-ordination at the National Levels**

This is carried out by the resident co-ordinator/resident representative of UNDP, thus ensuring good co-ordination with the activities of other organisations, either UN or regional, and of relevance to national views on the needs of the country in industrial-technological development. UNIDO has also Senior Industrial Development Field Advisers (SIDFA's), assisted by Junior Professional Officers (JPO's), who operate as an integral part of the UNDP office. Unfortunately, the number of such staff, specifically concentrating on industrial technological development, appears to have decreased due to reduced financial resources.

**In-House Co-ordination**

An organisational unit responsible for inter-agency co-ordination has been in operation since 1976. It is part of the External Relations Division, which includes also the unit for policy-making organs, and UNIDO liaison offices in Geneva and New York.

Because of the role technology plays in a tremendous variety of sectors and forms, UNIDO - with its central/lead co-ordinating role in industrial-technological development - needs to maintain a high level of interest and to continue to upgrade co-ordination mechanisms of its activities with all concerned bodies at all levels.

## X. NEW CONCEPTS AND APPROACHES IN UNIDO

The post-UNCSTD decade has witnessed the emergence of UNIDO as a fully-fledged UN organisation with a new constitution. Article 2(c) of this constitution states that UNIDO "shall ... create new and develop existing concepts and approaches in respect of industrial development on global, regional and national, as well as on sectoral levels". The implementation of this task is briefly reviewed hereunder because it is based on experiences and developments in the post-UNCSTD decade. UNIDO carried out an extensive review exercise which started by identifying the major issues in international industrial co-operation highlighting some critical areas of international cooperation that include:-

Technological, financial and managerial issues regarding the upgrading or rehabilitation and maintenance of established industrial structures in developing countries;

The stimulation of new investments in developing countries, including investments forming an integral part of existing industrial complexes,

and productive partnerships between regions or industrial communities in developed and developing countries;

The promotion and strengthening of small-scale industries as an integral part of the dynamic structure of industry in the developing countries;

The development of human resources for industrial development in developing countries;

Technological development for and through industrial development, and promotion of the transfer of technology with due attention to realising the potential for South-South co-operation.

Technology transfer occupies a prominent position amongst the target areas proposed for international cooperation in the review. Here distinction is made between the needs of developing countries at a relatively advanced level of technological development and those at an incipient level of technological development. While the first are pre-occupied with the need of facing up to the implications of the shifting frontiers of technology on the international division of labor, the urgent tasks for the latter are the sensitization of the population to basic scientific concepts and technical standards, keeping a window open to the ever-broadening spectrum of technologies, and upgrading their capability to choose and apply appropriate technology mixes.

The new emphasis on the development of small- and medium-scale industry recognizes that they contribute from 10-20% of GDP and 40-60% of industrial employment in developing countries. The limitations of the "trickle down" effect of larger industry underscores the importance of supporting small and medium-scale industries in stimulating indigenous development. Viewed individually, small enterprises in developing countries possess only a limited mixture of technology elements that need to be integrated with several other key technology elements, held in other enterprises or institutions, in order to complete the production process. The transfer of technology for small-industry development calls for innovative approaches, such as the enterprise-to- enterprise co-operation venture, eventually leading to the creation of a cluster of such ventures in a particular locality.

**The Medium-Term Plan**

The formulation of new concepts and approaches called for by the new constitution culminated in the drafting of a medium-term plan for the period 1990-1995. This is the mechanism by which UNIDO prepares itself for the 1990's, in particular in the field of industrial technology. The plan identifies the basic features of the 1980's - the post UNCSTD decade - as a period of uncertainty, instability and difficult adjustment for the world economy. Developing countries have been especially vulnerable to changes such as the fall in commodity prices, the steep rise in the price of oil and its subsequent fall, the recession of the early years of the decade in developed countries followed by slow growth and increasing protectionism, the volatility of exchange rates, and the accumulation of external debt surpassing the astronomical sum of one trillion dollars.

Consequently, the growth of industrial output of developing countries as a whole dropped from 4.5% in 1980 to 3.7% in 1985, recovering to 7.5% in 1986, only to drop again to 6% in 1987. It is highly unlikely that the target of 25% of the world total manufacturing value added as the share of developing countries will be achieved by the year 2000, as proclaimed in the Lima Declaration of 1975. Apart from countries in East, South-East Asia and the Indian subcontinent, most other developing countries have been overwhelmed by severe external imbalances calling for drastic structural adjustments while carrying out active measures of rehabilitation and investment to raise productivity of industry. While the newly-industrialising countries have managed to build a relatively well-trained and skilled work-force and score an impressive industrial record, the situation in many other developing countries is radically different. In the least developed countries, the share of manufacturing value-added in GDP has been declining. The situation is particularly disturbing in Africa where a process of deindustrialisation has actually set in. Parallel to these concerns over economic adjustment problems, new global non-economic concerns closely related to industry have emerged, particularly regarding the environment, the natural resource base, and the future world energy balance.

The medium-term plan proceeds next to characterise the major challenges of the 1990's, and UNIDO's response to them. It identifies eleven specific problem areas that call for innovative approaches, amongst which the development and transfer of technology occupies a central place. The challenges here are manifold. First, there is the inadequate flow of technology from the developed to the developing countries, having actually decreased rather than increased over the past few years. Secondly, the development of domestic technological capabilities is considered to be a more important factor than the transplantation of technology itself in the developing countries. Finally, long-term technology policies are needed to ensure the gradual establishment of capabilities in the capital goods sector. This is considered a "sine qua non" for establishing the technological dynamism resulting from the successful integration of industrial and technological development.

**UNIDO Integrated Technology Programmes**

UNIDO's experience over the post-UNCSTD decade and its new status have now converged into a set of consolidated programmes for the development and transfer of technology embodied in the document IDB. 3/26 and endorsed by the Industrial Development Board of UNIDO. The programmes make an important distinction between the development and transfer of S-T know-how and capability for production of a specific industrial good or service, on the one hand, and the establishment of a "technological system", on the other. These are made up of five modules, the contents of which were elaborated internally and tested with experts from both developed and developing countries.

First, the essential components of a technological system capable of development, adaptation and effective use of a given technology were identified as :

metrology, standardisation and quality control
research and development and its commercialisation including engineering, and product and process design
industrial and technological information, access to data banks and current events
entrepreneurship and general industrial management
a policy framework to promote the development and transfer of technology, including appropriate legislative and institutional measures.

The contents of the modules of the programmes for the development and transfer of technology can be summed up as follows:-

Technology Development and Capability Building

This covers:

Technology monitoring: which would draw on the work carried out in conventional sectors by the Industrial Policy and Perspectives Division and the System of Consultations Division. Monitoring new technological developments, however, requires first-hand experience in a wide range of new technological developments. Besides, a review of global technology trends, particularly those relating to international flows of technology, changes in the international technology market, and technological development in developing countries is also called for. An essential component of technology monitoring is the promotion of technology monitoring at the national and regional levels.

Promotion of technology policy formulation in a twofold approach, helping countries with a certain measure of capability to formulate technology policies and plans, while helping others to develop at least a minimum plan of action, or a kit of policy tools in the field of technology. This calls for co-operation with the Industrial Planning and the Regional and Country Studies Branches.

Research and Development and Commercialisation: Here the intention is to mobilise international co-operation on R&D in problems of great potential and significance to developing countries, at the regional and inter-regional levels, rather than invest UNIDO resources in R&D. Special attention will be paid to the new technologies, with emphasis on innovation for the benefit of small and medium-scale enterprises. Developing countries will be encouraged to review the working of their research laboratories, particularly in relation to their links with industry, so as to maximise returns from the substantial investments in setting up R&D institutions.

Promotion of basic technological infrastructure: Guidelines, including standardisation, quality control and design, will be drawn up so as to provide the necessary support for industrial production in developing countries. The experience of developed countries indicates that this involves long-term, multi-layer commitments bringing together a number of different disciplines, institutions and sources of funding, supported by leadership and individuals at the highest level in universities, corporations and government. The nurturing of university-industry interaction was also encouraged by the setting up of industrial or science parks and the increased availability of venture capital. All

this is a reflection of the fact that recent technological advances are becoming more and more science based.

Technology Transfer

These programmes are a reflection of the fact that most developing countries rely heavily on imported technology and focus on strengthening their capabilities in the acquisition of technology on the right terms, as well as intensifying technological co-operation at the enterprise level:

The technology acquisition programme builds on UNIDO's substantial experience in helping developing countries to acquire technology and centres on a wide spectrum of activities and mechanisms ranging from helping technology transfer registries to formulate policies for technology acquisition, to developing diversifying technological information exchange systems, co-operation among developing countries, strengthening capabilities in contract negotiations, technological advisory services, or strengthening information flows and support services on technology acquisition.

Technological Co-operation at the Enterprise Level: needs to be pursued vigorously, particularly between small- and medium-scale industries of developed and developing countries, and of the developing countries themselves. Activities in this respect include selection of sectors, identification of requirements and partners, assistance in concluding agreements, linking these activities to UNIDO technological advisory services. Co-ordination will be maintained with the work of the Industrial Policies and Perspectives/Country and Regional Studies, as well as the Industrial Institutions and Services Division of the Department of Industrial Operations.

Advanced Technologies

While continuing surveillance of several new technologies, further effort will concentrate on five areas, viz. genetic engineering and bio-technology, micro-electronics and information technology, new materials, marine industrial technology, and advances in manufacturing technology. Work in these areas will encourage appropriate policy responses of developing countries, building up capabilities selectively, mobilising international co-operation and linking these activities to investment. In each of these areas the programmes cover with appropriate variations in emphasis and modi operandi, information and need identification, stimulation of policy and programme formulation, transfer of technology through technological co-operation at different levels, promotion of applications and production facilities, capability building and supporting research.

Work in the areas of marine industrial technology and manufacturing technology is relatively new. In the first, activities will cover the promotion of marine industrial technology policies for island developing countries and other developing countries, and the establishment of specialised centres. It will also include technologies for the exploration and processing of marine resources, manufacturing technologies and production of equipment for such purposes. In the

manufacturing technology area, the scope for the application of flexible manufacturing systems in small-scale industries will be studied in depth, and projects demonstrating CAD in small- and medium- scale engineering workshops will be promoted.

Conventional Technologies

Here, there are six key programmes, viz. technologies for the rural poor, new and renewable sources of energy, technologies appropriate for small-scale industries, the promotion of UNIDO-generated technologies, the promotion of environmentally sound technologies and the preparation of sectoral technology briefs.

Some of these areas are not new and UNIDO has already been usefully active in them. These include new and renewable sources of energy, technologies for small-scale industries, appropriate technologies and sectorial technology briefs. Work in the second and third areas will be closely coordinated with the results of consultation meetings and technical assistance projects. Work in the area of technologies for the rural poor will continue to be based on the original concept of "technologies for humanity", with particular emphasis on food and fuel-related issues. In the area of environmentally sound technologies, there will be a wide spectrum of activities covering - inter alia - the promotion of low waste technologies, handling hazardous materials, industrial safety and emergency planning, legal and regulatory aspects. Co-operation and co-ordination will be maintained in this area with UNEP and the ECE.

Industrial and Technological Information

This includes the Industrial and Technological Information Bank (INTIB) which has now developed into a unique information system, with focal points at the national and regional levels, forming a network for the exchange of industry-relevant information of considerable variety. The programmes in this area cover the full range of modern information services, ranging from inquiry, on-line search, and a number of industry and technology related databases.

POSTSCRIPT

The formulation of a medium-term plan, taking stock of past experiences, UNIDO's new status and the international scene, is a logical development in preparing for the next phase of UNIDO operations. The consolidation of technology activities into programmes reflects the importance of technology in the medium-term plan. A programmatic approach calls for consideration of a number of important issues in planning and implementing projects. We end this report with brief reflections on these issues.

+A programme approach emphasises synergy, complementarity of various specialised inputs and logical sequencing of projects. It also implies cutting across line responsibilities. Planning and execution has to be in a "matrix" form of organisation, in which resources from different line organisational units work together synergistically to achieve the multi-faceted objectives of a particular project. This calls for exceptional management skills to nurture a "culture" of interdisciplinarity and to work out all the organisational details of such an approach.

+The claims of various worthwhile objectives call for establishing clear priorities in the programme areas and allocation of efforts and funds accordingly. However, UNIDO activities are strongly conditioned by the demands of the member states and their priorities. Only close interaction between UNIDO and the member states can guard against spreading efforts too thin to be effective. Without a clear definition of national points of view and foci of emphasis, UNIDO efforts could be rendered ineffective, or even misguided in extreme cases.

+This highlights the crucial role of UNIDO in strengthening the capacity of member states to formulate appropriate policies and plans for industrial development.

+There is still room to achieve closer linking of technology to industry and for greater effort and in-depth analyses of the complex issues involved in technological change.

+Monitoring technological developments, dissemination of information and assessments are important activities that must cont'nue. In fact, UNIDO has done an excellent job in the area of industrial technology at the conceptual level and in sensitisation to important issues. The next challenge now is to move more forcefully into operationalising these concepts.

+This calls for intensified effort to identify basic capacities in the field of the new technologies and strengthening them (e.g. integrated circuits, tissue culture, gene splicing, new engineering materials, etc.)

+It is hoped that promotional activities will now be further strengthened by the creation of a technology promotion division and a technology development division.

+Previous successes in developing appropriate technologies in some conventional fields should be extended. It is also necessary to explore the limits of UNIDO's ability to help in fields of proprietory know-how.

+Finally, handling the technology issues in the LDC's is still without a satisfactory approach. It is likely to remain so, at least for some time to come in view of the multiple constraints faced by those countries. This need not discourage continued effort to try and deal with them to UNIDO's best abilities.

ANNEX: TECHNOLOGIES ADAPTED AND PROMOTED BY UNIDO

A list of examples of technologies adapted and promoted by UNIDO through technical co-operation projects is given below.

Chemical industries sector

1. Manufacture of organo-phosphorus pesticides
2. A wettable powder formulation using jet micronizer
3. R and D projects for the development of new pesticides
4. Facilities for the toxicological evaluation of chemicals for national and international registration
5. Laboratory/scaling up operations for various pesticide formulations using locally available raw materials
6. New pilot-scale technologies for the industrial production of herbal pharmaceuticals
7. Industrial production of lime in small-scale installations
8. Industrial production of cement in installations of an appropriate scale
9. Industrial production of bricks and tiles by a mobile unit
10. Production of mother-of-pearl buttons
11. Application of bentonite in arid agriculture as sorbents
12. Industrial quarrying and processing technology for dimension stone
13. Integrated utilization of non-metallic minerals
14. Pigments based on natural non-metallic mineral resources
15. Processing of gem stones
16. Desilication of black liquors from chemical pulps using non-wood materials
17. Fibre fractionation of waste paper
18. Fibre fractionation of bamboo pulps
19. Modified lignin products from bamboo black liquors using ultra-filtration techniques
20. Salt production in solar evaporators in villages
21. Production of liquid natural rubber
22. Application and modification of liquid natural rubber
23. Thermoplastic rubbers
24. Composite rubber

Metallurgical industries sector

25. Development of alumina industry
26. Experimental tube digestion of bauxite
27. Preparation of a techno-economic study for upgrading the technology of an alumina plant
28. Bacterial leaching of copper from ores
29. Heap and/or *in situ* leaching followed by solvent extraction and electro-winning
30. Feasibility study on the extraction of gold from copper tailings
31. Technological investigation and comparative techno-economic evaluation for the commercial extraction of alumina from bauxitic clays

32. Techno-economic investigation for the production of de-ironed refractory bauxite

33. Establishment of a pilot and demonstration plant for the production of sponge iron

Engineering industries sector

34. Application of alternative fuels for internal combustion engines

35. Establishment of production units for serial production of manual pumps designed specifically for local conditions

36. Manufacturing of a solar water heater for industrial application

37. Assistance in the manufacture of agricultural material specific to local conditions

38. Regional research and development and training centre for mini-hydro-power generation

Agro-industries sector

39. Treatment of tannery effluents

40. Development of suitable software for CAD/CAM processing in the footwear industry

41. Coconut processing technology documents (parts 1-7) (UNIDO/IO.377 and Add.1-6)

42. Industrial production of coconut cream: The production concept (UNIDO/IO.528)

43. The case of Spirulina. Guide to spirulina algae processing operations for the production of food protein and natural pigments (UNIDO/IO.403 and UNIDO/IO.387)

44. A factory concept for integrated cassava processing operations (UNIDO/IO.534 and UNIDO/IO.582)

45. Definition of jojoba production and processing operations (UNIDO/IO.425)

46. Rice bran oil refining technology (UNIDO/IO.10)

47. The Balanites aegyptiaca - an unutilized raw material (potential) ready for agro-industrial exploitation (UNIDO/IO.494)

48. The production of non-toxic castor-bean meal free of allergens (UNIDO/IO.7(SPEC.))

49. The development of a rubber-seed processing technology for the production of vegetable oil and animal feed (UNIDO/IO.8(SPEC.))

50. The demonstration of a small-scale expeller unit for the production of coconut oil from copra

51. Indigenous fibres: the development of their processing technology and their use in textile products

52. Assistance to the China Ramie Technology Centre

53. Assistance to an applied reserach unit in the optimization of dyeing processes by using photospectrometers

54. Assistance to garment development centre in processing optimization in cutting and grading by the application of specially developed CAD systems

55. The use of CAD techniques to produce woven and printed textile designs, including shade matching

56. Use of unconventional fibres for the manufacture of fabrics

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